

Results Obtained —With— Ground Hobs

by
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WHENEVER a discussion is started concerning the relative merits of gears produced on

the hobbing machine or by any of the other recognized methods of gear cutting, the advocate of hobbing is almost sure to be confronted with the argument that the distortion of the hob in hardening results in the production of corresponding inaccuracies in the gear teeth generated with it. This fact is conceded by authorities on the subject, but it must be clearly understood that the error in gear teeth produced by a properly made hob which has been carefully heat-treated is very slight. In view of this fact, it is unfortunate that so much has been made of this point that many manufacturers who have not had much experience with hobbing machines and hobbled gears are inclined to think that the error assumes serious proportions, whereas it is really so slight as only to be objectionable in such cases as automobile transmissions, the gearing of cream separators, and similar mechanisms where the highest possible accuracy of the gearing is absolutely necessary. For all ordinary classes of gears, the distortion of the hobs that is produced in hardening does not prevent them from turning out work of the required accuracy.

The error in gears generated by properly made hobs that have been distorted in hardening is chiefly due to the production of flats on the gear teeth; and this results in noisy gears and the development of vibration in the machine on which they are used. The flats on such gear teeth are due to the distortion of the lead of the hob thread. A little thought will suffice to show that where the thread of the hob is distorted one way or the other—making the lead variable instead of uniform, as it should be—there will be points where the hob will cut too deep into the gear teeth, and other points where it will fail to cut to the required depth; and in either case the gear teeth will be of irregular form instead of following the required involute contour. For those classes of machines where great accuracy of the gearing is of primary importance, the distortion of the hobs that is produced in hard-

This article outlines the results of an investigation conducted for the purpose of determining the relative accuracy of hobs before and after grinding to eliminate the distortion produced while hardening; and to determine the improvement of the gears generated with the ground hobs over those produced by the unground hobs. For the purpose of securing the data on which the article is based, four unground hobs were tested to determine the lack of uniformity in the lead of the thread and diameter of the hob. Two gears were then generated with each of these four hobs, and the gears tested to determine their running properties and the relative accuracy of the contour of the teeth. Similar experiments were then conducted with four hobs which had been ground to correct for the distortion produced in hardening. The hobs tested were regular commercial tools and received no special treatment, so the results are representative of standard practice.

ening must be eliminated if the hobbing method is to be used with satisfactory results. The amount of unavoidable distortion of the hobs varies considerably, even where the best steel and most approved methods of hardening are employed. Some hobs of the same steel, which have been

heat-treated in the same manner, may be distorted to quite a noticeable extent, while others show virtually no distortion. But in order to be sure of the truth of all hobs which are to be used for generating very accurate gears, the only feasible method of procedure is to grind all of the hobs after they have been hardened, in order that the accuracy and uniformity of the lead of the thread may be insured.

At the present time there are several firms working on the development of machinery and methods for grinding hobs and, as the matter is new and one in which the mechanical public is taking a considerable interest at the present time, the writer went to the plant of the Illinois Tool Works, 154 East Erie St., Chicago, Ill., where every facility was offered him in securing the data which forms the basis of the present article. This firm is a pioneer in the art of grinding hobs and its product is being used by many of the best known automobile manufacturers in the country. Before starting to present the results which were obtained, it will not be out of place to briefly outline the information which was sought. The ultimate purpose was to determine the amount of improvement which was made in the gears by grinding the hobs with which they were generated; and it was also desired to learn how the accuracy of the hobs compared before and after grinding to correct for the distortion produced during the process of heat-treatment. For this purpose a series of tests was made, the first of which consisted of taking four 8-pitch hobs as they came from the furnace and grinding them in the gashes to sharpen the cutting faces of the teeth ready for use; but no attempt was made at this time to correct for the error in the uniformity of the lead of the thread produced in hardening. These hobs were then tested to determine the amount of error in the uniformity of the diameter, and the distortion of the lead of the thread. After this had been done for all four hobs, they were taken to an Adams-Farwell

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Fig. 1. Grinding Hobs in Gashes to sharpen Cutting Faces of Teeth

gear hobber and two gears were cut with each hob. These gears were then tested to determine their running properties and the accuracy of the teeth.

After this part of the test had been completed, four other 8-pitch hobs, after they had been ground to correct for the distortion of the lead of the thread, were sharpened ready for use. These hobs were next tested in the same way as the unground hobs, to determine the error in the uniformity of the diameter of the hob and the lead of the thread; and after this had been done, two gears were cut with each hob as in the preceding case, after which these gears were tested. With the data obtained from these tests—which is presented in Tables I to IV—it is possible to draw a definite conclusion as to the improvement of the gears which is secured through grinding the hobs.

Testing the Unground Hobs—Grinding the Gashes

In testing the first four hobs, which had not been ground to correct for the distortion of the lead of the threads, the first step was to sharpen the hobs, thus bringing them to the con-



Fig. 2. Grinding Backs of Hob Teeth to provide Locating Surfaces for Use in regrinding Hob

dition of the ordinary commercial hob made by the Illinois Tool Works. For this purpose, the hobs were transferred to a No. 2 tool grinder made by the Cincinnati Milling Machine Co. Each hob was mounted on a mandrel, as shown in Fig. 1, and an index plate *A* with the same number of spaces as there are gashes in the hob was mounted on the end of this mandrel. A spring steel leaf *B* carried by an adjustable arm *C* engaged the notches of the index plate to provide for locating the work in the proper position for grinding each gash.

In this connection, it may be mentioned that all of the hobs made by the Illinois Tool Works have the gashes accurately ground on both sides, *i.e.*, on the cutting faces of the teeth and the backs of the teeth. The reason for grinding the teeth on the back is that it provides accurately spaced finished surfaces which may be used for indexing when it is necessary to regrind the hobs in the shop where they are used. In grinding the backs of the teeth, the same adjustable arm *C* and spring leaf *B* are employed that were used in connection with the index plate *A* when grinding the cutting faces of the teeth; but in grinding the backs of the teeth, the index plate is not used, the spring leaf *B* being engaged by the finished cutting faces of the teeth, as shown in Fig. 2. After the teeth have been ground in this way, the diameter is tested with a special form of indicator, and must be uniform in order to pass inspection. The method of making this test will be described in a subsequent paragraph.

Testing the Accuracy of the Hobs

After the four hobs had been sharpened, they were taken to the inspection department in order to determine the

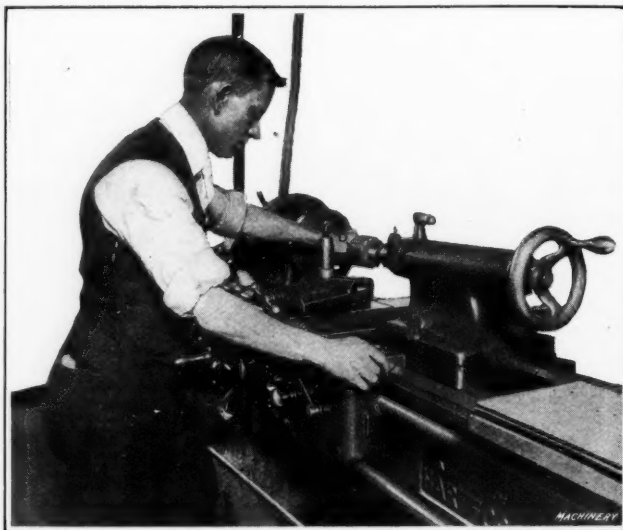


Fig. 3. Method of testing Uniformity of Hob Diameter

amount of error in the uniformity of the diameter of the hob and the lead of the thread. In making these tests, a special form of indicator known as a "testometer" was used. For testing the diameter of the hobs, this indicator was provided with the flat button-contact *D*, shown in Fig. 3, which runs over the outer cutting edges of the teeth. The diameter of each hob was tested at both ends. In this connection it must be clearly understood that the lack of uniformity in the diameter is not necessarily the result of distortion which occurred in the hardening process, as any inequality in the spacing of the cutting edges of the teeth will result in a variation of the results obtained from the diameter test. If such an error is found, the hob is returned to the grinding department where the required amount is removed from the cutting faces of the "high" teeth until the tests can be made with satisfactory results.

After the accuracy of the diameter had been determined, the hobs were tested to ascertain the amount of distortion of the lead of the thread which had occurred in hardening. For this purpose, a different form of contact was used on the testometer, this contact being a small sphere *E* which runs over the thread of the hob at approximately the pitch line, as shown in Fig. 4. Referring to Figs. 3 and 4, it will be seen that these tests were made on a Pratt & Whitney engine lathe, the hob being carried on a mandrel supported between

centers, and the indicator or testometer mounted in the tool-post. The lathe was used as if a thread cutting operation was being performed, the proper gears being engaged to traverse the carriage forward at the required rate to keep the indicator point in contact with the thread of the hob as it rotated. The indicator is graduated to read direct to 0.001 inch and the graduations on the dial are far enough apart so that quarter thousandths can be estimated with a very fair degree of accuracy. The readings were taken as the indicator point passed over the cutting edge of the tooth. The cone pulley was turned by hand, as the power would run the lathe too fast to enable accurate readings of the indicator to be taken. Before starting the test, the cross-slide was adjusted to make the first reading of the testometer 0.010, so that any variation in the lead is shown by the difference of the testometer reading from the initial reading. All four hobs were tested in this way and the results obtained are shown in Table I, the results being expressed in thousandths of an inch.

The Special Hob Testing Machine

The use of the engine lathe for testing hobs has been found unsatisfactory, owing to the inconvenience of operation, although the results obtained are all that can be desired from the standpoint of accuracy. To provide for handling this work in a more efficient manner, the Illinois Tool Works recently designed the special hob testing machine shown in Figs. 7 and 8. This machine was in course of construction at the time the writer obtained the data presented in this article. As the tabulated results were obtained from tests

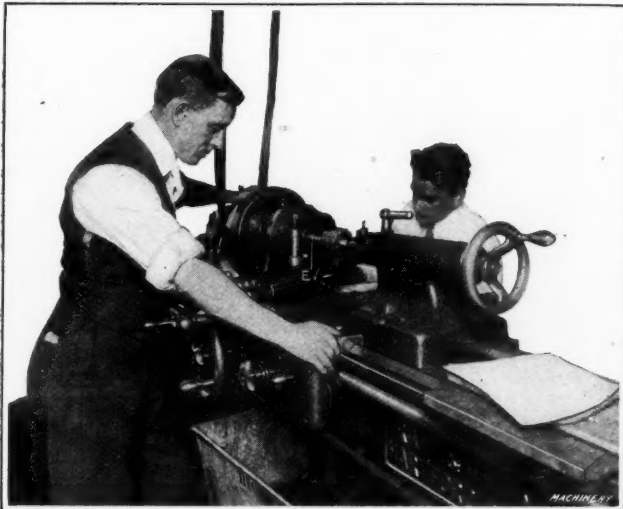


Fig. 4. Testing to determine Error in Uniformity of Lead of Thread produced in Hardening Process

made on the engine lathe, this method of conducting the tests is illustrated; but as the lathe has now been replaced by the special testing machine, it seems desirable to present a brief description of the features of the equipment which is now used.

By providing a special testing machine, it is only natural that far greater convenience of operation should be provided for. Referring to Fig. 7, it will be seen that the hob testing machine is provided with centers, between which the hob to be tested is supported on a mandrel. Located above the centers there is a slide on which the indicator carriage is supported. This carriage is provided with two indicators, and is traversed along its slide by the usual form of lead-screw which is turned by a handle *F* at the right-hand end of the machine. The carriage can be swiveled for spiral-gashed hobs, to enable both of the indicator needles to engage the cutting edges of the teeth at the same time. At the left-hand end of the lead-screw there is mounted the first of a set of change gears, which makes connection with the head of the machine. As in the case of the engine lathe, these gears are provided to enable the proper relation to be obtained between the traverse of the carriage and the rotation of the hob, so that the indicator points keep in proper contact with the thread as the hob rotates. It will be seen that the two indicators are employed, one indicator testing the uniformity

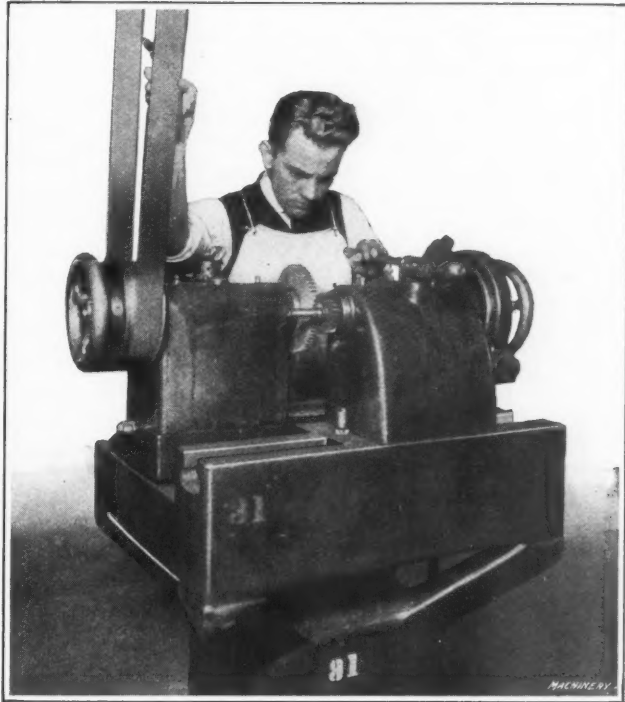


Fig. 5. Gleason Machine for testing Running Properties and Tooth Bearing of Spur Gears

of each side of the hob thread. This enables the tests to be conducted much more rapidly than was possible when the lathe was used, because if it was required to test both sides of the thread when the test was made on the lathe, the test had to be repeated, it only being possible to take readings for one side of the thread at a time.

Connection is made from the indicators to the hob by means of two small bellcrank levers *G*. As in the case of the tests conducted on the engine lathe, an initial reading of 0.010 inch is the starting point; and the indicators are adjusted to give this reading by regulating the position of the small cross-slide on the carriage. It will be seen that there is a graduated dial at the left-hand end of the lead-screw. Ordinarily, the indicator readings are taken as the points of the bellcrank levers *G* pass over the cutting edges of the hob teeth. In certain cases, however, it may be desired to take readings at some other specified point on the thread of the hob, as when it is required to prove the accuracy of the lead of the hob thread, when an error is found in the spacing of the gashes; and this would not be possible without the graduated dial which shows when the contact points of the bellcrank levers are in the proper position to take the reading. This machine is now being used for testing all of the hobs made by the Illinois Tool Works and is said to be giving very satisfactory results. Suitable charts have been laid out for each pitch and size of hob, and the use of these charts greatly simplifies the making of the tests.

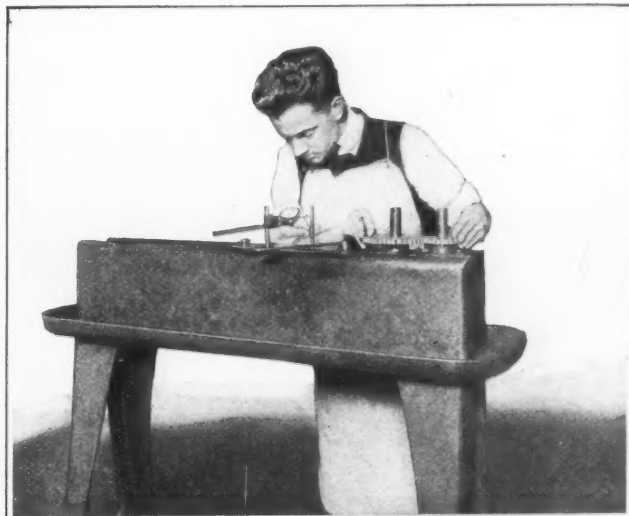


Fig. 6. Brown & Sharpe Machine for testing Accuracy of Gears

Generating and Testing the Gears

After all four of the hobs had been tested in the manner described, they were taken out to the shop and one hob after another was set up on an Adams-Farwell gear hobber. A gear and a pinion were generated with each hob and these gears were then tested to determine their running properties and the accuracy of their teeth. For use in testing the running properties, the Gleason spur gear testing machine shown in Fig. 5 was employed. This machine has only been on the market for about a year, and so it will not be out of place to refer briefly to the purpose for which it is used and the method of operation. There are two draw-in spindles on the machine on which the gears to be tested are mounted; and the position of one of the heads may be varied to adjust the center distance between these spindles as required. One of the spindles is driven from the countershaft in the usual way, and the other is provided with a band brake for use in applying a load on the gear teeth. In this way it is possible to form an idea of the running properties of the gears by the amount of noise which they make when running at high speed; and the character of the bearing surface of the teeth is shown by the fact that those portions of the teeth which engaged with each other are smoothed down, while the remainder of the tooth surface still shows the tool marks left by the hob.

In conducting the series of tests with which this article is concerned, the gear and pinion generated by each hob were run together in the machine, and the results of the test are shown for the unground hobs in Table II and for the ground hobs in Table IV. In running the gears generated by the unground hobs, there was quite a noticeable amount of noise, while in the case of gears generated by the ground hobs, the only noise produced was a dull humming sound. Although the bearing of the gear teeth generated by the unground hobs was fairly good in all cases, it was not so uniform over the full working surface of the teeth as in the case of the gears generated by the ground hobs.

In order to determine the accuracy of the tooth contour of the test gears generated by the hobs, the gears were taken to a Brown & Sharpe gear tester, where they were set up suc-

cessively in mesh with a master gear. For the benefit of those readers who are not familiar with this machine, we will refer briefly to the way in which it is used. The master gear and the gear to be tested are mounted on two studs, the position of one stud being fixed while the other is carried by a slide. At the opposite end of

this slide there is a stud of smaller diameter, and carried in the same bearing with the slide on which the gear stud is supported there is a second slide carrying another small stud to which a dial test indicator is secured. The set-up of the machine is clearly shown in Fig. 6. The gears are rotated by hand, and any inaccuracy causes a longitudinal movement of the slide on which one of the gears is supported, the amount of this movement being shown on the dial of the test indicator. A whole revolution of the gears shows the amount of the eccentricity of the bore, but the machine can also be satisfactorily employed for showing an error in the contour of the teeth by noting the deflection of the indicator needle while passing over a single tooth. This was the purpose for which the machine was used in conducting the present investigation. Each gear was

moved through a complete revolution and the deflection of the indicator needle was noted for each tooth. In the tabulated data, the maximum error of the teeth of each gear represents the greatest error that was found for any one tooth in going all the way around the gear.

How the Hobs are Ground to Correct for Lack of Uniformity in Lead

It will be evident to anyone who has given much thought to the subject that the only way of grinding the sides of the thread of a hob is by providing a mechanism of the general character of a relieving attachment. By the method used in the plant of the Illinois Tool Works, a small conical shaped wheel is mounted on a reciprocating slide which enables the wheel to follow the contour of the hob teeth as produced on the backing-off lathe. The principle of the mechanism of this special grinding machine is shown in Fig. 9. To allow for the grinding operation, from 0.002 to 0.0025 inch of metal is allowed on each side of the thread at the pitch line, and from 0.008 to 0.012 inch on the diameter, this allowance being varied somewhat according to the pitch of the hob and the kind of steel from which it is made. The hobs are completely ground on the sides and top face of the thread, after which they are taken to the tool grinder and the cutting faces and backs of the teeth are ground as previously described for the ordinary commercial hobs.

In making the test of hobs on which the thread has been ground to eliminate the distortion produced in hardening, it

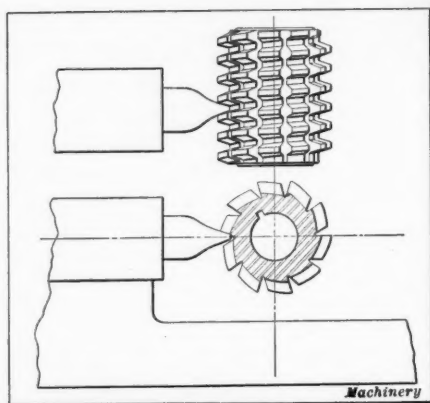


Fig. 9. Diagram showing Method of grinding to correct for Errors in Uniformity of Lead of Thread

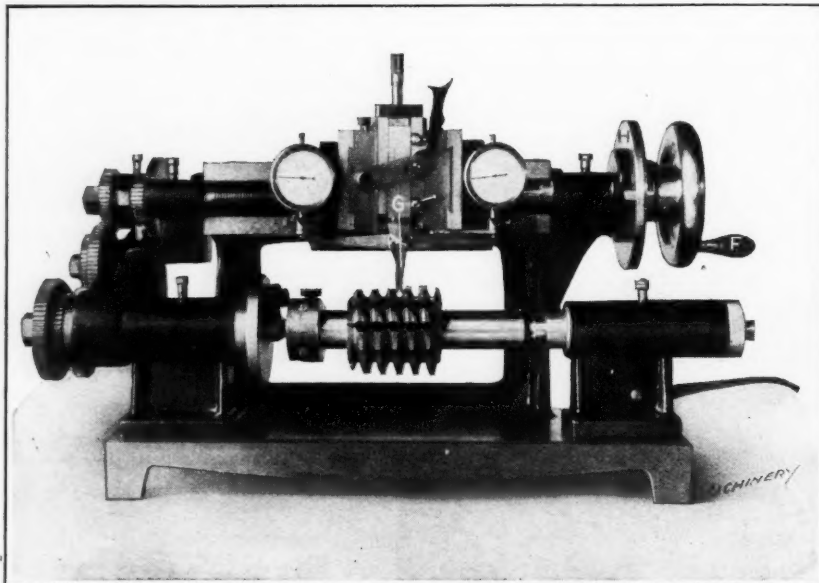


Fig. 7. Special Hob Testing Machine now used by Illinois Tool Works

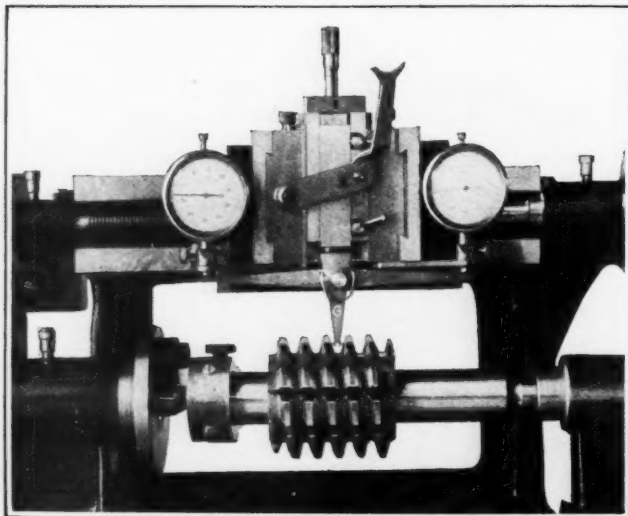


Fig. 8. Close View of Indicator Carriage and Hob to be tested

TABLE I. RESULTS OF TESTS OF HOBS BEFORE GRINDING TO REMOVE DISTORTION PRODUCED IN HARDENING*

Test of Hob No. 1									Test of Hob No. 3								
Circumferential Row No.	Cross Row No.							Deviation in Cross Rows	Circumferential Row No.	Cross Row No.							Deviation in Cross Rows
	7	6	5	4	3	2	1			7	6	5	4	3	2	1	
1	7 $\frac{1}{2}$	9 $\frac{1}{2}$	9	8 $\frac{3}{4}$	10 $\frac{1}{2}$	9 $\frac{1}{2}$	10	2 $\frac{1}{2}$	1	11	9 $\frac{3}{4}$	11	12	10	12	10	2 $\frac{1}{2}$
2	7 $\frac{1}{2}$	8 $\frac{1}{2}$	9 $\frac{1}{2}$	8 $\frac{1}{2}$	10 $\frac{1}{2}$	9 $\frac{1}{2}$	9 $\frac{1}{2}$	2 $\frac{1}{2}$	2	10 $\frac{3}{4}$	11 $\frac{1}{2}$	10 $\frac{3}{4}$	12	10 $\frac{3}{4}$	11	11 $\frac{1}{2}$	1 $\frac{1}{2}$
3	7 $\frac{1}{2}$	6 $\frac{3}{4}$	9	8 $\frac{1}{2}$	8 $\frac{1}{2}$	10	9 $\frac{1}{2}$	3 $\frac{1}{2}$	3	10	12	10 $\frac{3}{4}$	10 $\frac{3}{4}$	12 $\frac{1}{2}$	10 $\frac{3}{4}$	10 $\frac{3}{4}$	1 $\frac{1}{2}$
4	7 $\frac{1}{2}$	7	8 $\frac{1}{2}$	9 $\frac{1}{2}$	8 $\frac{1}{2}$	9 $\frac{1}{2}$	10	3	4	9 $\frac{3}{4}$	11 $\frac{1}{2}$	12 $\frac{1}{2}$	10 $\frac{3}{4}$	12 $\frac{1}{2}$	10 $\frac{3}{4}$	11	2 $\frac{1}{2}$
5	7 $\frac{1}{2}$	8	7 $\frac{1}{2}$	9	8 $\frac{1}{2}$	8 $\frac{1}{2}$	9 $\frac{1}{2}$	2 $\frac{1}{2}$	5	10	10 $\frac{3}{4}$	13	11	11 $\frac{1}{2}$	12 $\frac{1}{2}$	9 $\frac{3}{4}$	3 $\frac{1}{2}$
6	6	8 $\frac{1}{2}$	7 $\frac{1}{2}$	8	8 $\frac{1}{2}$	8 $\frac{1}{2}$	7 $\frac{1}{2}$	2 $\frac{1}{2}$	6	10 $\frac{3}{4}$	9 $\frac{3}{4}$	11 $\frac{1}{2}$	12 $\frac{1}{2}$	10 $\frac{3}{4}$	12	12	2 $\frac{1}{2}$
7	5 $\frac{1}{2}$	8 $\frac{1}{2}$	8 $\frac{1}{2}$	8	8 $\frac{1}{2}$	9	7 $\frac{1}{2}$	3 $\frac{1}{2}$	7	10 $\frac{3}{4}$	10 $\frac{3}{4}$	10 $\frac{3}{4}$	12 $\frac{1}{2}$	10 $\frac{3}{4}$	11	12 $\frac{1}{2}$	2
8	6	7 $\frac{1}{2}$	8 $\frac{1}{2}$	8 $\frac{1}{2}$	8 $\frac{1}{2}$	9 $\frac{1}{2}$	8 $\frac{1}{2}$	3 $\frac{1}{2}$	8	9 $\frac{3}{4}$	11 $\frac{1}{2}$	9 $\frac{3}{4}$	10 $\frac{3}{4}$	11 $\frac{1}{2}$	10 $\frac{3}{4}$	11 $\frac{1}{2}$	2
9	6 $\frac{1}{2}$	7 $\frac{1}{2}$	7 $\frac{1}{2}$	8 $\frac{1}{2}$	8 $\frac{1}{2}$	9 $\frac{1}{2}$	9 $\frac{1}{2}$	3 $\frac{1}{2}$	9	11	11 $\frac{1}{2}$	11	9 $\frac{3}{4}$	10 $\frac{3}{4}$	10 $\frac{3}{4}$	10 $\frac{3}{4}$	1 $\frac{1}{2}$
10	5 $\frac{1}{2}$	7 $\frac{1}{2}$	7 $\frac{1}{2}$	9 $\frac{1}{2}$	9 $\frac{1}{2}$	9 $\frac{1}{2}$	11	5 $\frac{1}{2}$	10	12 $\frac{1}{2}$	10 $\frac{3}{4}$	12	9 $\frac{3}{4}$	10 $\frac{3}{4}$	11 $\frac{1}{2}$	9 $\frac{3}{4}$	2 $\frac{1}{2}$
11	5 $\frac{1}{2}$	8 $\frac{1}{2}$	7 $\frac{1}{2}$	8 $\frac{1}{2}$	10 $\frac{1}{2}$	9 $\frac{1}{2}$	10 $\frac{1}{2}$	5	11	11 $\frac{1}{2}$	9 $\frac{3}{4}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	9 $\frac{3}{4}$	11	10 $\frac{3}{4}$	2
12	..	8 $\frac{1}{2}$	9 $\frac{1}{2}$	8 $\frac{1}{2}$	10 $\frac{1}{2}$	9 $\frac{1}{2}$	9 $\frac{1}{2}$	1 $\frac{1}{2}$	12	11 $\frac{1}{2}$	9 $\frac{3}{4}$	10 $\frac{3}{4}$	11 $\frac{1}{2}$	10	10 $\frac{3}{4}$	12	2 $\frac{1}{2}$
Deviation in Circumferential Rows	2 $\frac{1}{2}$	2 $\frac{1}{2}$	2	1 $\frac{1}{2}$	2 $\frac{1}{2}$	1 $\frac{1}{2}$	3 $\frac{1}{2}$	..	Deviation in Circumferential Rows	2 $\frac{1}{2}$	2 $\frac{1}{2}$	3 $\frac{1}{2}$	2 $\frac{1}{2}$	2 $\frac{1}{2}$	2	2 $\frac{1}{2}$	..
Hob runs out 0.00125 inch on the diameter.									Hob runs out 0.0015 inch on the diameter.								
Test of Hob No. 2									Test of Hob No. 4								
Circumferential Row No.	Cross Row No.							Deviation in Cross Rows	Circumferential Row No.	Cross Row No.							Deviation in Cross Rows
	7	6	5	4	3	2	1			7	6	5	4	3	2	1	
1	7 $\frac{1}{2}$	7	9 $\frac{1}{2}$	9	9 $\frac{3}{4}$	10	10	3	1	10 $\frac{3}{4}$	9 $\frac{3}{4}$	10	10 $\frac{3}{4}$	9 $\frac{1}{2}$	11	10	1 $\frac{1}{2}$
2	7 $\frac{1}{2}$	6 $\frac{1}{2}$	8 $\frac{1}{2}$	9	8 $\frac{3}{4}$	10	9 $\frac{1}{2}$	3 $\frac{1}{2}$	2	10 $\frac{3}{4}$	10	9	11 $\frac{1}{2}$	10 $\frac{3}{4}$	10 $\frac{3}{4}$	11 $\frac{1}{2}$	2 $\frac{1}{2}$
3	7	6 $\frac{1}{2}$	7	8 $\frac{1}{2}$	8 $\frac{3}{4}$	8 $\frac{1}{2}$	9	2 $\frac{1}{2}$	3	9 $\frac{1}{2}$	10 $\frac{3}{4}$	9 $\frac{1}{2}$	11	12 $\frac{1}{2}$	10 $\frac{3}{4}$	12 $\frac{1}{2}$	3 $\frac{1}{2}$
4	5 $\frac{1}{2}$	6 $\frac{1}{2}$	6 $\frac{1}{2}$	8	8 $\frac{3}{4}$	7	8 $\frac{1}{2}$	3 $\frac{1}{2}$	4	9 $\frac{1}{2}$	11	10 $\frac{3}{4}$	10 $\frac{3}{4}$	13 $\frac{1}{2}$	11 $\frac{1}{2}$	10 $\frac{3}{4}$	4
5	4 $\frac{1}{2}$	6 $\frac{1}{2}$	6 $\frac{1}{2}$	7 $\frac{1}{2}$	8 $\frac{3}{4}$	8	6 $\frac{1}{2}$	4 $\frac{1}{2}$	5	9 $\frac{1}{2}$	10	12	11 $\frac{1}{2}$	12 $\frac{1}{2}$	12 $\frac{1}{2}$	11	3
6	5 $\frac{1}{2}$	5 $\frac{1}{2}$	6 $\frac{1}{2}$	7	8	9	7	3 $\frac{1}{2}$	6	10 $\frac{3}{4}$	10 $\frac{3}{4}$	12	12	11 $\frac{1}{2}$	13 $\frac{1}{2}$	12 $\frac{1}{2}$	3 $\frac{1}{2}$
7	5	5 $\frac{1}{2}$	7 $\frac{1}{2}$	8	7 $\frac{3}{4}$	9 $\frac{3}{4}$	8 $\frac{1}{2}$	4 $\frac{1}{2}$	7	10 $\frac{3}{4}$	11	10 $\frac{3}{4}$	13	11 $\frac{1}{2}$	12 $\frac{1}{2}$	12 $\frac{1}{2}$	2 $\frac{1}{2}$
8	5 $\frac{1}{2}$	6 $\frac{1}{2}$	6 $\frac{1}{2}$	9 $\frac{1}{2}$	9	9 $\frac{3}{4}$	9 $\frac{3}{4}$	4	8	8 $\frac{1}{2}$	11	10	11 $\frac{1}{2}$	12	11 $\frac{1}{2}$	12 $\frac{1}{2}$	4 $\frac{1}{2}$
9	5	8	7 $\frac{1}{2}$	9	10 $\frac{1}{2}$	9 $\frac{1}{2}$	10 $\frac{1}{2}$	5 $\frac{1}{2}$	9	8 $\frac{1}{2}$	11	10	10 $\frac{3}{4}$	12 $\frac{1}{2}$	11 $\frac{1}{2}$	10 $\frac{3}{4}$	4 $\frac{1}{2}$
10	4 $\frac{1}{2}$	8 $\frac{1}{2}$	7 $\frac{1}{2}$	8 $\frac{1}{2}$	11 $\frac{1}{2}$	10	10	6 $\frac{1}{2}$	10	9	10 $\frac{3}{4}$	11 $\frac{1}{2}$	10 $\frac{3}{4}$	10 $\frac{3}{4}$	12	9 $\frac{1}{2}$	3
11	..	7	9 $\frac{1}{2}$	9	10 $\frac{3}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	3 $\frac{1}{2}$	11	9	8 $\frac{1}{2}$	10 $\frac{3}{4}$	10 $\frac{3}{4}$	9 $\frac{3}{4}$	11 $\frac{1}{2}$	9 $\frac{1}{2}$	2 $\frac{1}{2}$
12	..	7	8 $\frac{1}{2}$	9 $\frac{1}{2}$	9 $\frac{1}{2}$	11	10	4	12	..	9	9 $\frac{3}{4}$	10 $\frac{3}{4}$	9 $\frac{3}{4}$	10 $\frac{3}{4}$	10	1 $\frac{1}{2}$
Deviation in Circumferential Rows	2 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$	2 $\frac{1}{2}$	3 $\frac{1}{2}$	4	3 $\frac{1}{2}$	..	Deviation in Circumferential Rows	2 $\frac{1}{2}$	2 $\frac{1}{2}$	3	2 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$	..
Hob runs out 0.0015 inch on the diameter.									Hob runs out 0.0015 inch on the diameter. Machinery								

* Note: Tabulated values represent thousandths of an inch.

is often found that there are places where the lead of the thread is not sufficiently uniform to pass the rigid inspection to which these hobs are subjected; and such hobs must be returned to the grinding department to be "touched up." Where the error on the thread occurs at a point where the thread is slightly too thick, the correction is made by merely grinding the required amount of metal from the side of the thread. In case the error is due to too much metal having already been removed from the thread, the correction is made by grinding down the top of the tooth and increasing the depth of the tooth space a similar amount, thus making a reduction of the pitch radius of the hob at this point. It must be clearly understood in this connection that the amount of error which is being eliminated in this way is exceedingly small, and while such an amount of error on the side of the hob thread would be objectionable, the

error in the pitch radius introduced by the method of correction referred to is quite negligible. The heading illustration shows a ground hob to the left and an unground hob at the right, and illustrates the complete way in which the teeth of the "ground" hobs are gone over on the grinding machine. The sides of the thread are ground right to the bottom, and the bottom of the thread can be ground if necessary. This is done in the case of hobs used for generating worm-wheels, where the bottom of the

hob thread finishes the top of the teeth on the worm-wheel. The same is true of some hobs used for generating spur gears. As previously stated, four of the ground hobs were tested in the manner that has already been described for the "unground" or ordinary commercial hobs; two gears were then cut with each of the ground hobs, and tested. The results are shown in Tables III and IV.

TABLE II. RESULTS OBTAINED WITH UNGROUND HOBS*

	Hob No. 1	Hob No. 2	Hob No. 3	Hob No. 4
Maximum deviation in the cross rows of hob teeth.....	5 $\frac{1}{2}$	6 $\frac{1}{2}$	3 $\frac{1}{2}$	4 $\frac{1}{2}$
Maximum deviation in the circumferential rows of hob teeth	3 $\frac{1}{2}$	4	3 $\frac{1}{2}$	3 $\frac{1}{2}$
Running properties of the gear and pinion.....	Rather Noisy	Rather Noisy	Rather Noisy	Fair
Character of bearing on the teeth...	Not uniform	Bearing at one side of tooth and from pitch line to point	Poor at one side of the tooth	Fairly uniform
Maximum error in the gear teeth.....	1	2 $\frac{1}{2}$	2	2
Maximum error in the pinion teeth...	2 $\frac{1}{2}$	1 $\frac{1}{2}$	2	2

* Note: Tabulated values represent thousandths of an inch.

Conclusion

In order to reach a conclusion as to the amount of improvement which has been made through grinding the hobs to secure uniformity of the lead of the thread, reference should be made to Tables II and IV, where it will be seen that the horizontal rows of data in Table II give the results for the four unground hobs which were tested, and in Table IV data is presented for the four ground hobs. The first two rows in each of these tables are a recapitulation from Tables I and III, respectively, and nothing need be said by way of emphasizing the improvement in the uniformity of the lead of the hob threads which has been effected by the grinding process. In regard to the running properties and character of the bearing surface of the teeth of the gears generated by the two sets of hobs, it has already been stated that the gears produced by the ground hobs were far superior in that they ran more quietly and that the bearing surface on the teeth was far more uniform. As regards the maximum error found in the teeth of the gear and pinion generated with each hob, it will be seen from the tables that in the case of the gears produced with the unground hobs the average error is about double that in the gears produced by the ground hobs.

In this connection, it must be understood that the results obtained on the Brown & Sharpe gear testing machine, which was used for making these tests, afford a reliable means of getting comparative values of the error in the contour of different gear teeth, but the results do not represent the actual amount of error which existed. A comparison of these results will show that a very marked improvement has been made through grinding the hobs to eliminate the distortion produced in hardening; and for those cases where the greatest

TABLE IV. RESULTS OBTAINED WITH GROUND HOBS*

	Hob No. 5	Hob No. 6	Hob No. 7	Hob No. 8
Maximum deviation in the cross rows of hob teeth.....	1	1	$\frac{1}{2}$	1
Maximum deviation in the circumferential rows of hob teeth....	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	1
Running properties of the gear and pinion...	Quiet	Fair	Quiet	Quiet
Character of bearing on the teeth.....	Uniform	Uniform	Uniform	Uniform
Maximum error in the gear teeth.....	1	$\frac{3}{4}$	1	1
Maximum error in the pinion teeth.....	1	1	1	$\frac{3}{4}$

* Note: Tabulated values represent thousandths of an inch.

possible accuracy of the gearing is required, the use of ground hobs is highly desirable. The development of the method for producing these accurate hobs has undoubtedly been of great service to manufacturers who desire to make use of the hobbing machine for producing very accurate gears. But for all ordinary classes of gears, the additional expense of ground hobs is not justified, as the required accuracy can be easily attained with hobs which have not been ground to correct for the relatively small error produced in hardening.

TABLE III. RESULTS OF TESTS OF HOBS AFTER GRINDING TO REMOVE DISTORTION PRODUCED IN HARDENING*

Test of Hob No. 5									Test of Hob No. 7								
Circumferential Row No.	Cross Row No.							Deviation in Cross Rows	Circumferential Row No.	Cross Row No.							Deviation in Cross Rows
	7	6	5	4	3	2	1			7	6	5	4	3	2	1	
1	9 $\frac{1}{4}$	9 $\frac{1}{2}$	9 $\frac{3}{4}$	9 $\frac{1}{2}$	9 $\frac{3}{4}$	10	10	$\frac{3}{4}$	1	10 $\frac{1}{4}$	10	10	10	10	10	10	$\frac{1}{4}$
2	9 $\frac{1}{4}$	9 $\frac{1}{2}$	9 $\frac{3}{4}$	9 $\frac{1}{2}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	$\frac{3}{4}$	2	10 $\frac{1}{4}$	10	10	10	10	10	10	$\frac{1}{4}$
3	9	9 $\frac{1}{4}$	9 $\frac{1}{2}$	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	1	3	10 $\frac{1}{4}$	10	10	10	10	10	10	$\frac{1}{4}$
4	9	9 $\frac{1}{4}$	9 $\frac{1}{2}$	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	1	4	10	10	10	10	10	10	10	0
5	9	9 $\frac{1}{4}$	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	1	5	10	10	10	10	10	10	10	0
6	9	9	9	9	9 $\frac{1}{4}$	9 $\frac{1}{4}$	9 $\frac{3}{4}$	$\frac{3}{4}$	6	10	10	10	10	10	10	10	0
7	9	9	9	9	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	$\frac{1}{2}$	7	10	10	10	10	10	10	10	0
8	8 $\frac{3}{4}$	9	9	9	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	1	8	10	10	10	10	10	10	10	0
9	8 $\frac{3}{4}$	9	9	9 $\frac{1}{4}$	9 $\frac{1}{4}$	9 $\frac{1}{4}$	9 $\frac{3}{4}$	1	9	10	10	10	10	10	10	10	0
10	9 $\frac{1}{4}$	9	9 $\frac{1}{4}$	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	1	10	10 $\frac{1}{4}$	10	10	10	10	10	10	$\frac{1}{4}$
11	9 $\frac{1}{4}$	9 $\frac{1}{4}$	9 $\frac{1}{4}$	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	$\frac{3}{4}$	11	10 $\frac{1}{2}$	10	10	10	10	10	10	$\frac{1}{2}$
12	..	9 $\frac{1}{4}$	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	$\frac{3}{4}$	12	10	10 $\frac{1}{4}$	10	10	10	10	10	$\frac{1}{4}$
Deviation in Circumferential Rows	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	..	Deviation in Circumferential Rows	$\frac{1}{2}$	$\frac{1}{4}$	0	0	0	0	0	..
Hob runs out 0.0005 inch on the diameter.									Hob runs out 0.001 inch on the diameter.								
Test of Hob No. 6									Test of Hob No. 8								
Circumferential Row No.	Cross Row No.							Deviation in Cross Rows	Circumferential Row No.	Cross Row No.							Deviation in Cross Rows
	7	6	5	4	3	2	1			7	6	5	4	3	2	1	
1	9	9	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	1	1	10	10	10	10	10	10	10	0
2	9	9	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	1	2	10	10	10	10	10	10	10	0
3	9	9	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	1	3	10	10	10	10	10	10	10	0
4	9	9 $\frac{1}{4}$	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	1	4	10	10	10	10	10	10	10	0
5	9	9 $\frac{1}{4}$	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	$\frac{3}{4}$	5	10	10	10	9 $\frac{3}{4}$	10	10	10 $\frac{1}{4}$	$\frac{1}{2}$
6	9	9	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	$\frac{3}{4}$	6	10 $\frac{1}{4}$	10	10	10	10	10	10	$\frac{1}{4}$
7	9	9	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	$\frac{3}{4}$	7	10	10	10	10	10	10	10	0
8	9	9	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	$\frac{3}{4}$	8	10	10	10	10	9 $\frac{3}{4}$	9 $\frac{3}{4}$	10	$\frac{1}{4}$
9	8 $\frac{3}{4}$	9	9	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	1	9	10	10	10	10	9 $\frac{3}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	$\frac{1}{4}$
10	9	9	9	9	9 $\frac{1}{4}$	10	9 $\frac{3}{4}$	1	10	10 $\frac{1}{4}$	10 $\frac{1}{4}$	10	10	10	10	10	$\frac{1}{4}$
11	9	9	9	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	$\frac{3}{4}$	11	11	10 $\frac{1}{4}$	10	10	10	10	10	1
12	9	9	9	9	9 $\frac{1}{4}$	9 $\frac{3}{4}$	9 $\frac{3}{4}$	$\frac{3}{4}$	12	11	10	10	10	10	10	10	1
Deviation in Circumferential Rows	$\frac{1}{4}$	$\frac{1}{4}$	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	..	Deviation in Circumferential Rows	1	$\frac{1}{4}$	0	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$	..
Hob runs out 0.001 inch on the diameter.									Hob runs out 0.0005 inch on the diameter.								

* Note: Tabulated values represent thousandths of an inch.

Machinery

THE FLOATING PRINCIPLE AS APPLIED TO FIXTURE WORK

EXAMPLES OF FIXTURES IN WHICH THE FLOATING PRINCIPLE IS ILLUSTRATED

BY ALBERT A. DOWD*

THERE are many instances in the design and construction of fixtures for machine tool equipment work that require application of the floating principle in order to make them thoroughly efficient. When thin castings are to be handled, the application frequently takes the form of a system of floating clamps, which are arranged in such a way that pressure sufficient to hold the work can be applied without danger of distorting it. It may also be necessary to have the locating points so designed that they too will float to a certain extent so that they will adapt themselves to varying conditions. The latter application is most frequently indicated in cases where rough castings are to be machined so that inequalities in the work will not affect the product by imperfect locating. Abnormal or extraordinary conditions sometimes require the application of the floating principle to the location of work which has two or more finished surfaces in different planes, and considerable ingenuity is apparent in some of the devices used in cases of this kind.

The nature of the castings for which the fixtures are designed has a strong influence on their construction, and the type of machine tools on which they are to be used is also a prominent factor in the design. The accuracy required in the finished product, and the number of pieces to be machined must also be considered in connection with the design.

Fixtures of this kind may be adapted for work on various kinds of machine tools, such as drill presses, milling machines, lathes (turret and engine types), boring mills or grinding machines. All of these require fixtures of somewhat different construction, according to the machines on which they are to be used, and the purpose for which they are intended.

It is naturally out of the question to cite examples of every kind of device to which the floating principle can be applied,

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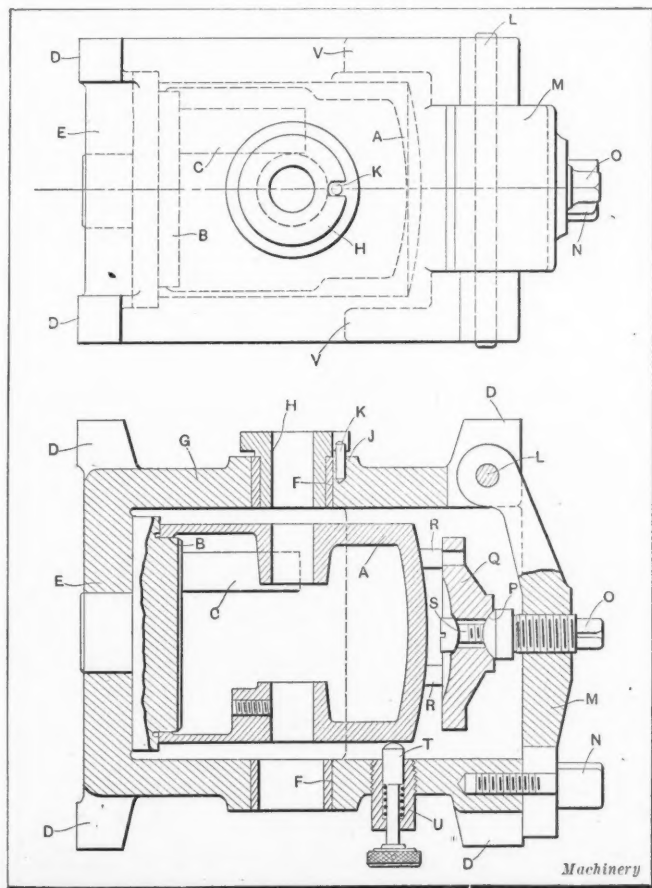


Fig. 1. Piston Drill Jig with Floating Clamps

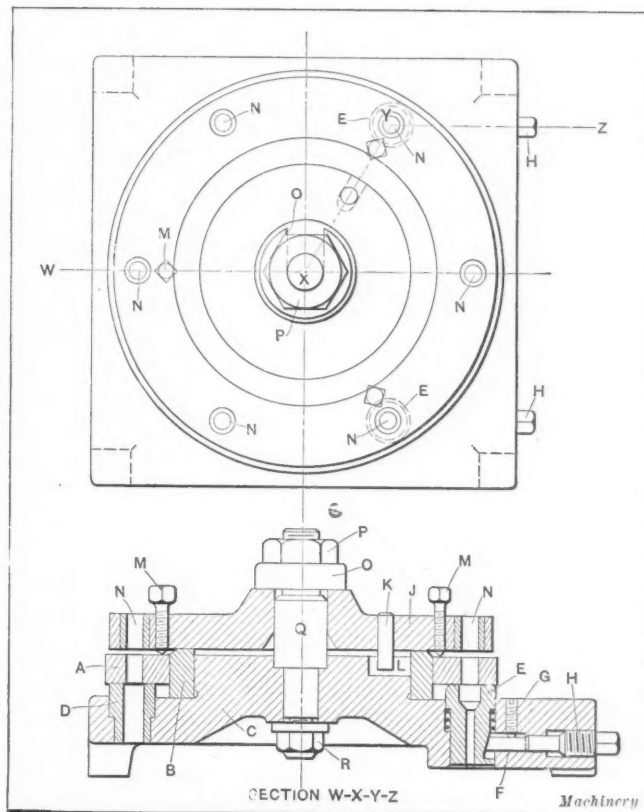


Fig. 2. Drill Jig for Rough Steel Collar

but an attempt will be made to cover the field in such a way that various applications of the devices shown may be made to cover a wide range of work.

It is well to state that in connection with the application of the floating principle, the greatest care must be used in the design in order to make sure that it is correctly applied, for it is quite possible to obtain a "float" in some portion of a device or tool, which, being of faulty construction, will not produce the results desired. (Several examples of both good and bad floating reamer types are noted in a discussion of this subject which appeared in the July, 1913, MACHINERY, under the heading "Floating Reamer Holders.")

Important Points in the Application of the Floating Principle

In order to obtain the most satisfactory results in its application, a few points are here noted which are worthy of attention.

1. As applied to clamping or holding methods, the greatest care must be used in order to make sure that the floating action is not constrained in any one direction, but will operate equally well and with uniform pressure on the required area. Frictional resistance may at times be sufficient in cases of this kind to cause imperfect work by reason of unequal pressures on the work itself. When the clamping action is applied to a rough surface, still greater care must be used in this regard, and the amount of float must be so proportioned that it will take care of a considerable variation in the castings or forgings. When a great number of pieces are to be handled, several patterns are often used and these will be found to vary somewhat so that there are slight differences in the resulting castings. For this reason due allowance must be made.

2. When applied to methods of locating the work, or as supporting points on which it rests, the construction must be such that it will not by any possibility cause distortion. If springs are used under supporting plugs which are afterward to be locked in position, the springs must be proportioned so that they will not be strong enough to cause any trouble by

forcing the piece out of its true position. Also when supports are placed against finished surfaces they should be so arranged that they will not injure them. In locating a piece of work from two previously machined surfaces which are in different planes, the float-action must be very carefully studied,

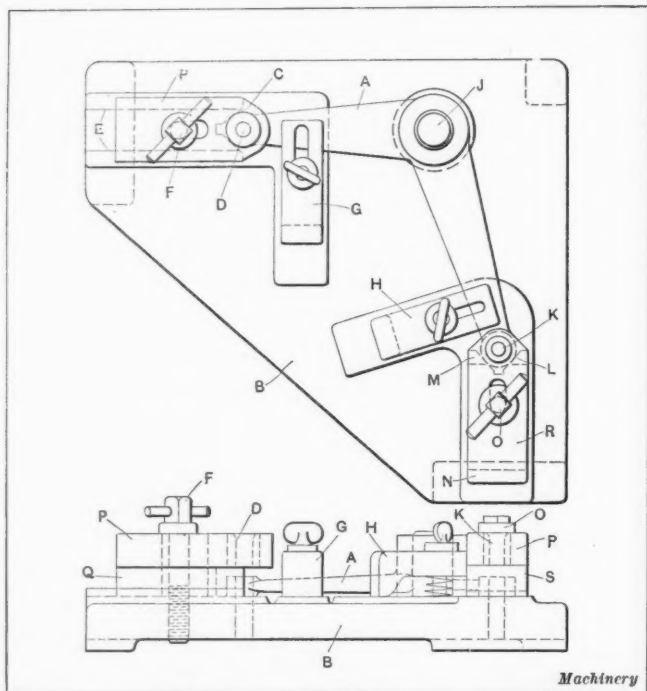


Fig. 3. Drill Jig with Floating Bushings and Locating Vees

and every refinement provided so that the contacts are positively assured, and no "cocking" of the work will result. There are occasional instances which require the location of a piece of work from a previously machined surface, in connection with a threaded portion by which it must be clamped. In a case of this kind the "float" must be made so that it will take care of a possible lack of concentricity between the thread and the other finished surfaces and at the same time provide means of equalizing variations in the alignment of the thread.

3. Locking devices for floating members must be arranged so that the members can be positively locked or clamped without causing any change in their positions. A turning action such as might be caused by the end of a screw against a locating point is sometimes sufficient to throw the work out of its correct position. The interposing of shoes between the screws and the floating members will prevent any trouble of this kind.

Other points in construction and design will be noted in

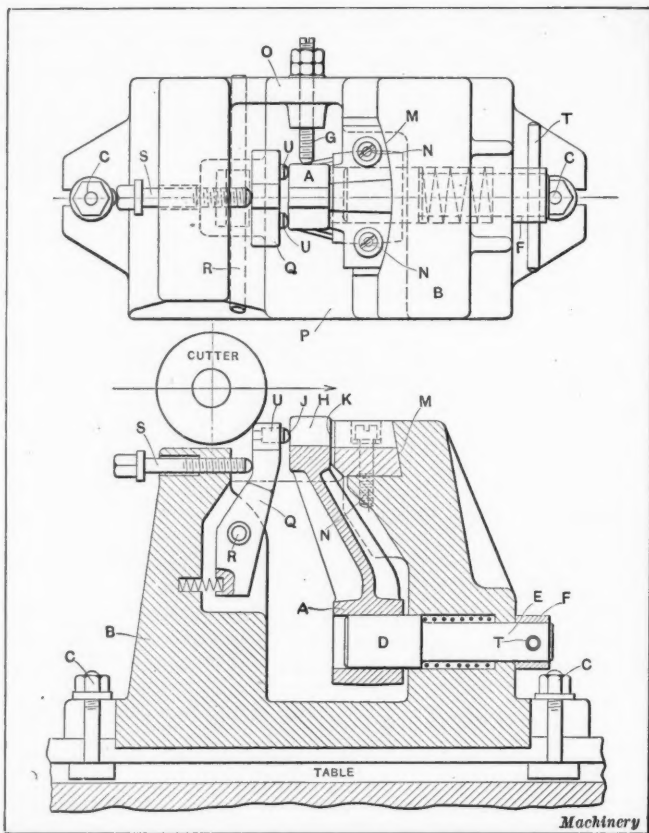


Fig. 4. Milling Fixture with Floating Clamps and Locator

connection with the examples given during the progress of this article.

Piston Drill Jig with Floating Clamps

A very good example of a drill jig which is provided with a floating clamp to work on a rough surface is shown in Fig. 1, the work in question being a piston casting *A* which has been previously machined at *B*. The body of the jig *G* is of semi-box section and is provided with feet *D* on which it may be rested, both during the loading and when under the drill. A hardened and ground steel stud *E* is let into the casting at one end and served as a locating point for the machined interior of the piston *B*. A stud *C* is further provided to give the correct location to the wrist-pin bosses.

As the end of the piston is of spherical shape and in the rough state also, it is necessary to provide a means of clamping which will so adjust itself to the inequalities of the casting that an equal pressure will be obtained so that there will be no tendency to cock or tip the work. A heavy latch *M* is pivoted on the pin *L* and is slotted at the other end to al-

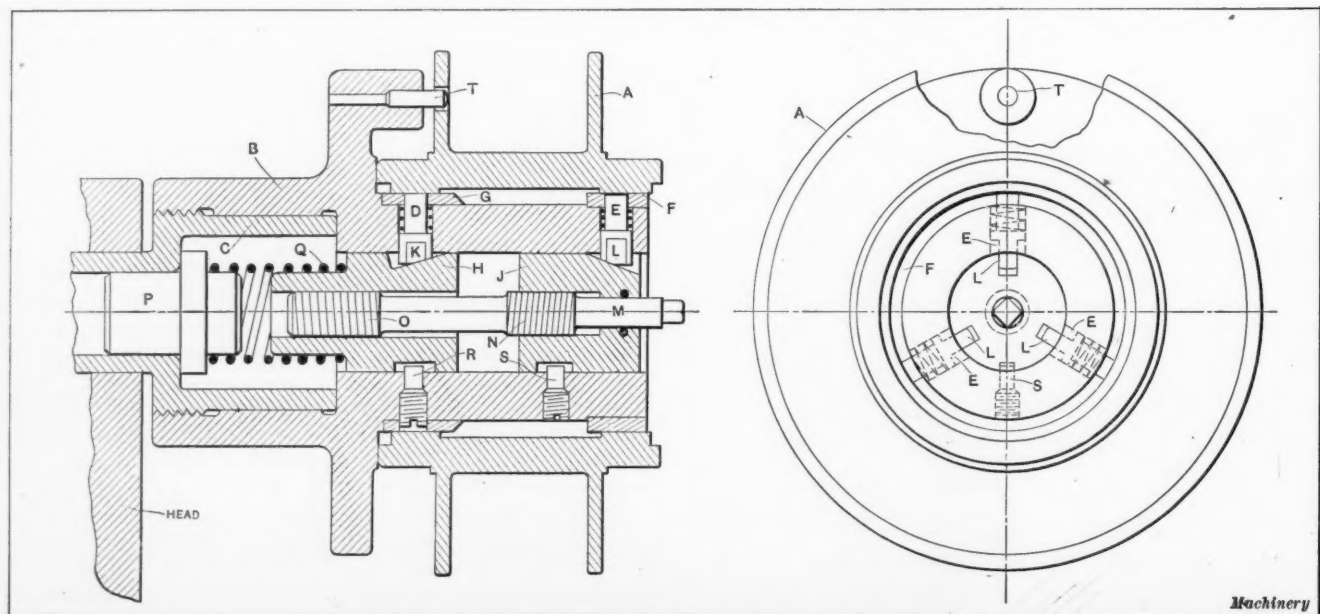


Fig. 5. Locating Device with Floating Pressure Compensator

low the passage of the thumb-screw *N* which is used to clamp it in position. A special screw *O* is threaded into the latch, and is ball-ended at *P* so that it has a spherical bearing against the floating clamp *Q*. The screw *S* keeps it in position, but it will be noted that clearance is provided to allow for the floating movement

around the body of the screw. Three pins *R* are set 120 degrees apart in the face of the floating clamp so that a firm three-point bearing is assured. In order to assist in supporting the work under the pressure of the drill, two spring pins *T* are provided, these being set in the form of a vee near the front end of the piston. They are encased in a screw bushing *U* and are locked in position by means of set-screws, not shown, after they have been allowed to spring up against the piston casting. (In order to avoid confusion in the drawing, one of these pins is shown at an angle of 45 degrees from its actual position.)

The steel liner bushings *F* are provided in the body of the casting so that the main bushings, which are of the removable type as shown at *H*, may not produce too much wear in the jig body itself. A slot is provided in the head of the bushing so that the pin *K* will prevent it from turning under the twisting action of the drill. It should be noted that in the construction of the spring-pins which are used to help support the casting, the springs themselves should be very light so that they will not force the piston out of its true position, determined by the locating stud.

Drill Jig for a Rough Steel Collar

The steel adjusting collar *A* which is shown in Fig. 2 has been previously bored, but no other work has been done upon it, the sides being left in their natural forged shape. Six holes are to be drilled around the rim, as shown at *N*, and it

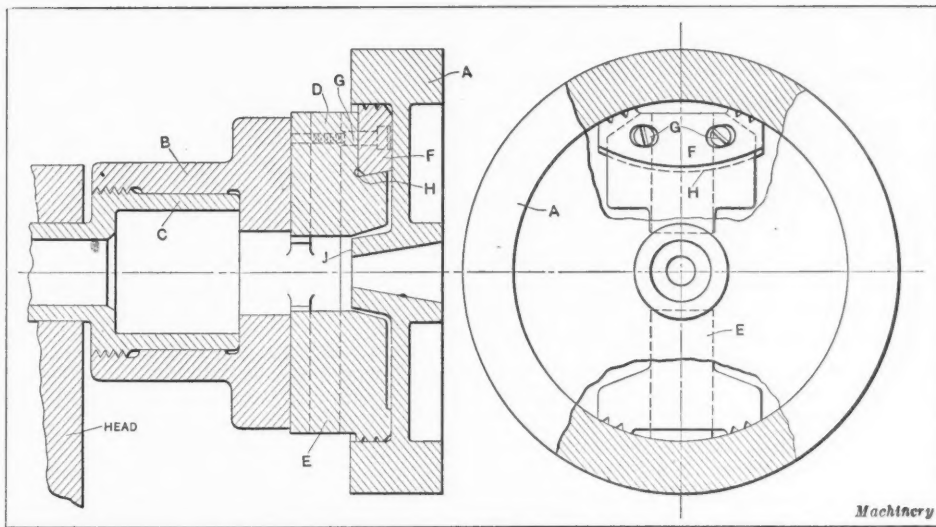


Fig. 6. Two-jawed Chuck arranged with a Floating Jaw

located. The ring is placed on this steel collar resting against the single steel bushing *D* which is inserted in the body of the jig. Two other bushings *E* are arranged 120 degrees apart, and are provided with very light coil springs which force them up against the under side of the ring. The shoes *F* are then set up against the angular cut on these bushings by means of the screws *H*. The small set-screws *G* bear against the flattened side of the shoes and prevent them from turning. It will be noted that the angular cut on the body of the bushings is such as to prevent them from pushing down under the pressure of the drill.

The bushing plate *J* is located on the stud *Q* and is prevented from turning by the pin *K* which fits the slot *L* in the body of the jig. Six bushings *N* are set into the plate at equal intervals. A nut *P* and a C-washer *O* provide for ready removal of the plate and draw it down solidly on the top of the locating ring *B*. The three pointed screws *M* are set into the work slightly to prevent any change in its location. It is well to note that it would have cost no more to machine one side of the work while it was being bored, thus obviating the necessity of the floating locating bushings.

Drill Jig with Floating Bushings and Locating Vees

A somewhat peculiar condition is shown in Fig. 3, the work *A* being a bell-crank of ordinary construction such as is used in large quantities in automobile work. There are some instances on work of this kind when a variation of 1/32 inch

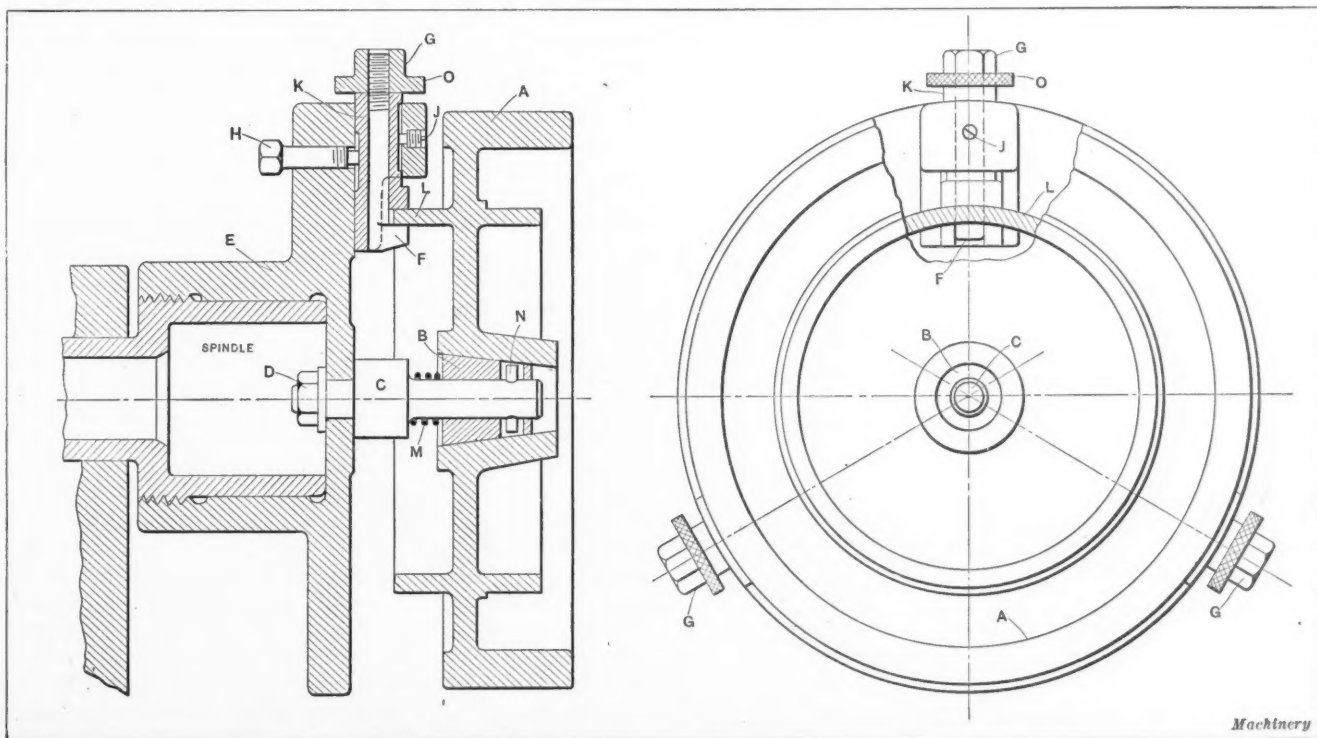


Fig. 7. Chucking Fixture with Floating Clamp and Taper Locating Plug

or more in the center-to-center distances is not considered of extreme importance, but it is quite important to have the holes as near the center of the bosses as possible. In order to counteract variations in the castings and still obtain holes which are central on the bosses, it was necessary to adopt some sort of floating construction such as that shown in the illustration. A number of jigs of this kind are in use in a large automobile factory in New England, and their action is very satisfactory. In the instance shown the work is located on a stud *J* from the previously reamed hole in the hub. It should also be noted that both hubs and bosses have been faced to size previous to the drilling operation. A sliding V-block *Q* is carefully fitted to the slot *E* in the body of the jig, and on it is mounted the bushing plate *P* in which the bushing *D* is carried. After the piece has been placed in position the sliding block is pushed forward by the operator until the vee *C* comes up against the boss on the casting and locates it. The thumb-screw *F* locks the block firmly in position, and the sliding clamp *G* holds the work. Another block *S* is also cut out in the form of a vee at *L*, but is not tongued on its lower side to fit a slot, as in the other instance. A bushing plate *R* is mounted on it with a bushing *K* at the forward end. The under side of the block has two narrow bearing surfaces *N* and *M* and it is free to swivel in any direction required by the slightly varying positions of the boss. The thumb-screw *O* holds it in place after it has been located by the operator. The other clamp *H* is then used to hold the piece firmly. A drill jig of this kind is not suited to all classes of work, but the floating action gives excellent results when absolute accuracy is not required.

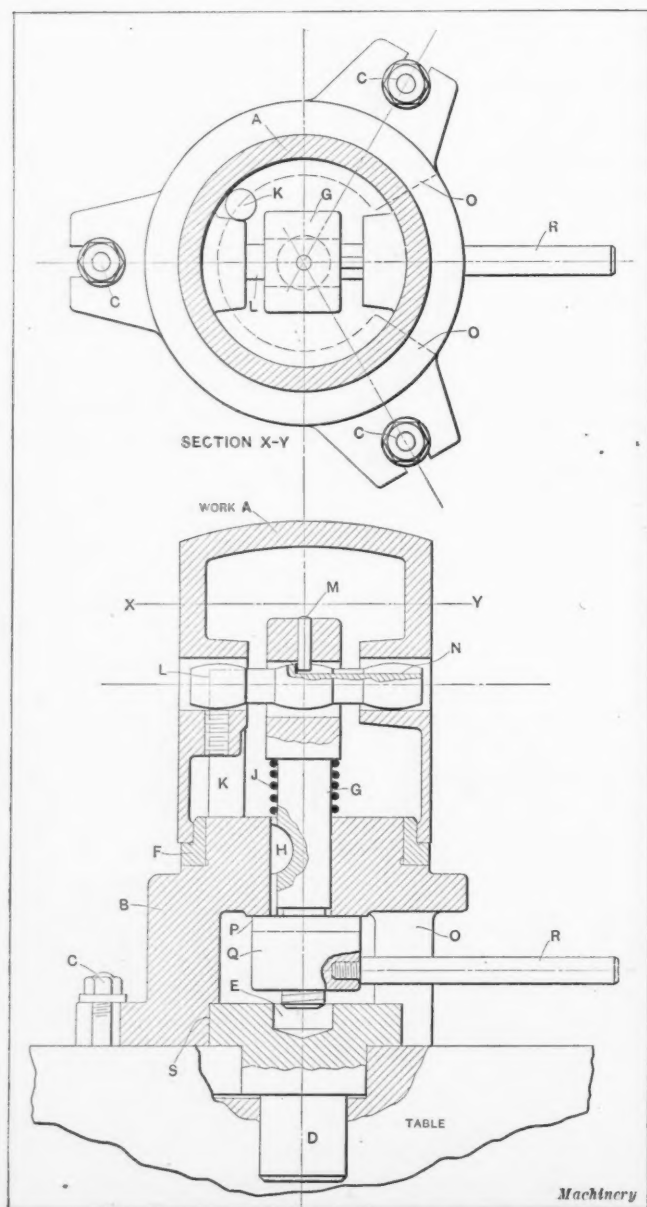


Fig. 8. Piston Chuck having Floating Clamping Features

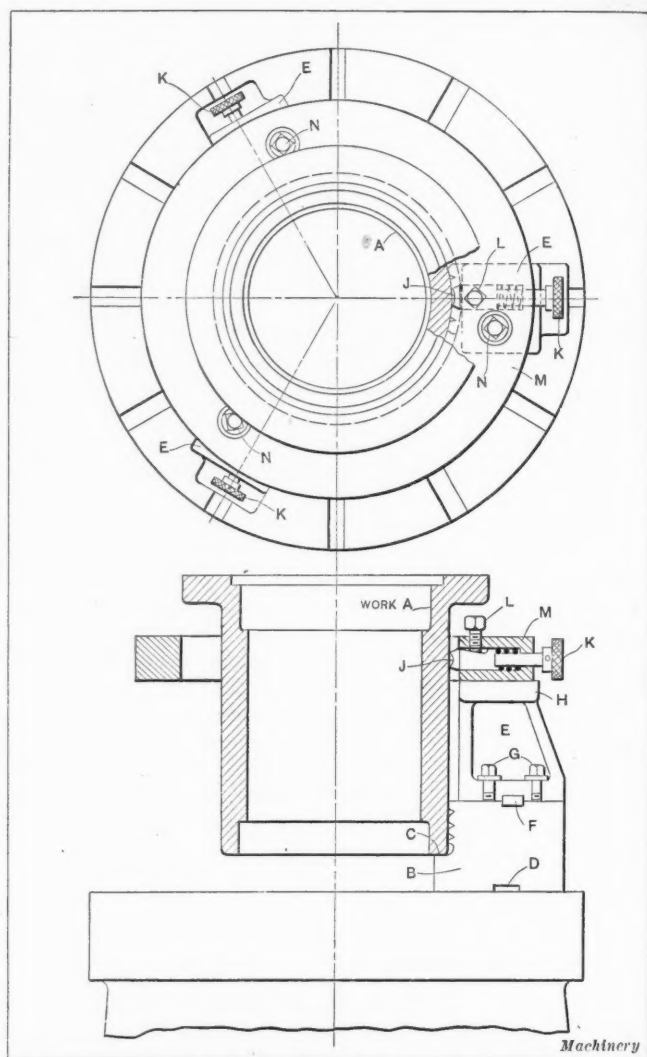


Fig. 9. Chuck Jaws with Floating Locating Points

Milling Fixture with Floating Clamps and Locator

In the design of milling fixtures a point which is of extreme importance is that of so arranging the various clamping devices that they will not produce undue strain or distortion. In addition to this all members used must be of sufficiently heavy construction to avoid all possibility of chatter. The work *A* as illustrated in Fig. 4 has been previously chucked and it is desired to mill the slot *H* at its upper end in a certain relation to the reamed hole. The two portions of the casting *J* and *K* are left rough, and as a consequence it becomes necessary to arrange the clamps and locating points so that they will equalize the inequalities of the casting. The body of the fixture *B* is cast iron and of somewhat heavy section, being tongued at its lower side to fit the slot in the table and held down in the usual manner by the tee-bolts *C* at each end. The work is placed on the adjustable plunger *D* which is pulled back by the pin *T* passing through the outer end. A stop collar *F* is forced onto the end of the shank *E* in order to prevent too great a movement of the plunger. The upper end of the work is swung over against the stop-screw *G* which is set in a boss in the rib *O* that ties the two sides of the fixture together. One of the rough sides *K* of the casting strikes against the rocker *M* which automatically adjusts itself to the variation in the casting. It will be noted that the fixture is bored out radially and slightly under-cut to fit this rocker, and that it is held in place by the screws *N*. The holes which these screws enter are slightly enlarged to permit the necessary movement. Two steel pins *U* bear against the other side of the rough casting, these pins being set in swinging floating clamp *Q*, the provision for float being supplied by an over-sized hole at *R*. The set-screw *S* bears against the center of this rocking clamp and gives the pressure necessary to hold the work. A small coil spring throws the clamp back out of the way when assembling or disassembling the work. Attention is called to the fact that

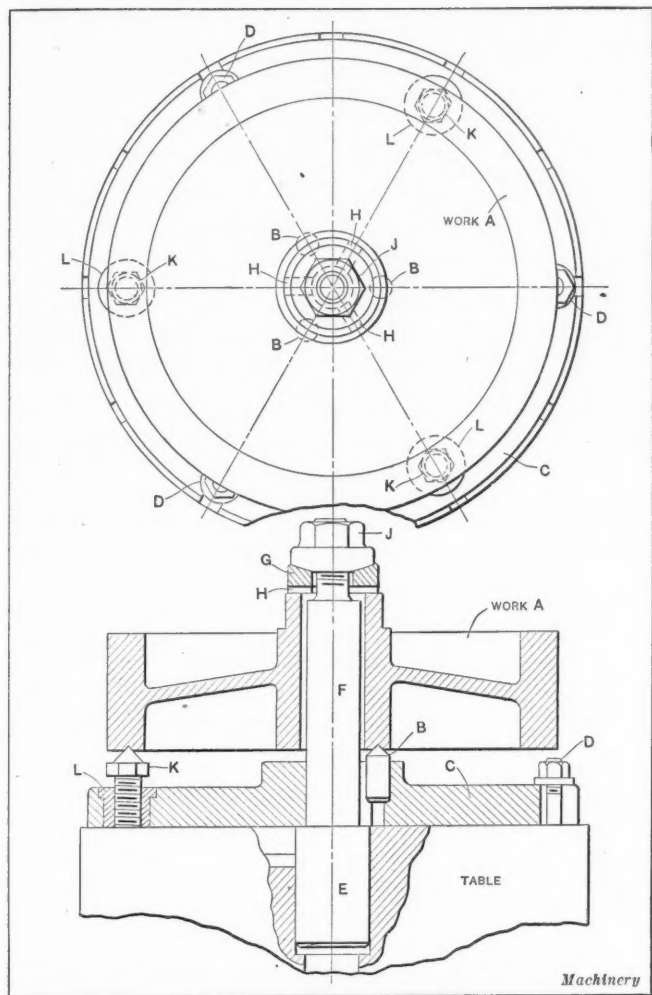


Fig. 10. Roughing-out Fixture for a Motor Gear

the direction of the cut in machining the slot is such that the pressure comes against the solid body of the casting and not against the clamp.

Locating Device with Floating Pressure Compensator

The work *A* shown in Fig. 5 has been partially machined in a previous operation, and the flange has also been drilled so that one of the holes can be used for driving purposes. The machine to which this device is applied is a turret lathe of the horizontal type, and the body *B* is screwed to the spindle end *C* in the usual manner. The pin *T* is set into a boss in the face of the fixture and acts as a driver in one of the flange holes. Two steel rings *F* and *G* act as approximate locators for the work when it is first placed on the fixture. Two cylindrical steel cams *H* and *J* are accurately ground to fit the central hole in the fixture, and are operated by the rod *M* which is threaded right- and left-hand, respectively, at *N* and *O*. Each cam is milled to a 20-degree angle at *K* and *L*, three of these slots being equally spaced around the periphery so that their angular surfaces control the movement of the locating pins *D* and *E*. The coil springs return the pins to an inactive position when released by the cams. A plug *P* is placed in the spindle as shown in the illustration, for the purpose of providing a seat for the coil spring *Q* which assists in the releasing of the pins after the machining has been done. The two stop-pins *R* and *S* limit the movement of the cams and take all the thrust of the twisting action of the operating screw.

In this connection it is well to note that these stop-pins are a nice fit in the cam slots, while the locating pins have a side clearance in the angular slots of 0.010 inch so that there is no possibility of trouble being caused by friction at these points. Attention is further called to the fact that the action of the cams is such that a true floating motion is produced when the screw is operated so that all of the locating pins are set up with an equal amount of pressure. A floating action of this nature may be readily applied to holding fixtures for a great variety of work.

Chucking Fixture with Floating Clamps and Taper Locating Plug

A somewhat unusual condition is shown in Fig. 7, the work *A* being a special clutch flywheel which has been partially machined in a prior setting. In order to obtain concentricity of the various surfaces, it is obviously necessary to locate the work from the taper in the hub. In order to compensate for slight variations between the taper and other finished surfaces, a tapered shell locating bushing *B* is centrally located on the stud *C* which is held in place in the faceplate fixture *E* by the nut and washer at *D*. A light coil spring *M* insures a perfect contact with the tapered surfaces, while a small pin *N* restrains the movement. As the outside of the work is to be finished during this setting, it is necessary to grip the casting in such a way that the clamps will not interfere with the cutting tools, nor cause distortion in the piece itself. With this end in view the three lugs around the rim of the fixture are provided with shell bushings *K*, each of which is squared up at its inner end to form a jaw which is bored to a radius corresponding with the rim of the casting *L*. It is splined to receive a test screw *J* which prevents it from turning, and it also gets a good bearing directly under the point where the work is held so that there is no danger of springing out of shape.

The bolts *F* pass through the shell bushings and are furnished with nuts *G* at their outer ends, the nuts having a knurled portion *O* which permits of rapid finger adjustment before the final tightening with a wrench. It will be seen that this construction automatically obtains a metal-to-metal contact with the thin flange of the casting without distorting it in the least, as the floating action of the bushings equalizes all variations and yet holds the work very firmly. After the clamps have been set up tightly, they are locked in position by the set-screws *H* at the rear of the fixture. This application of the floating principle may be adapted to many kinds of work, and the results obtained leave nothing to be desired. The machine on which this device is shown is a turret lathe of the horizontal type.

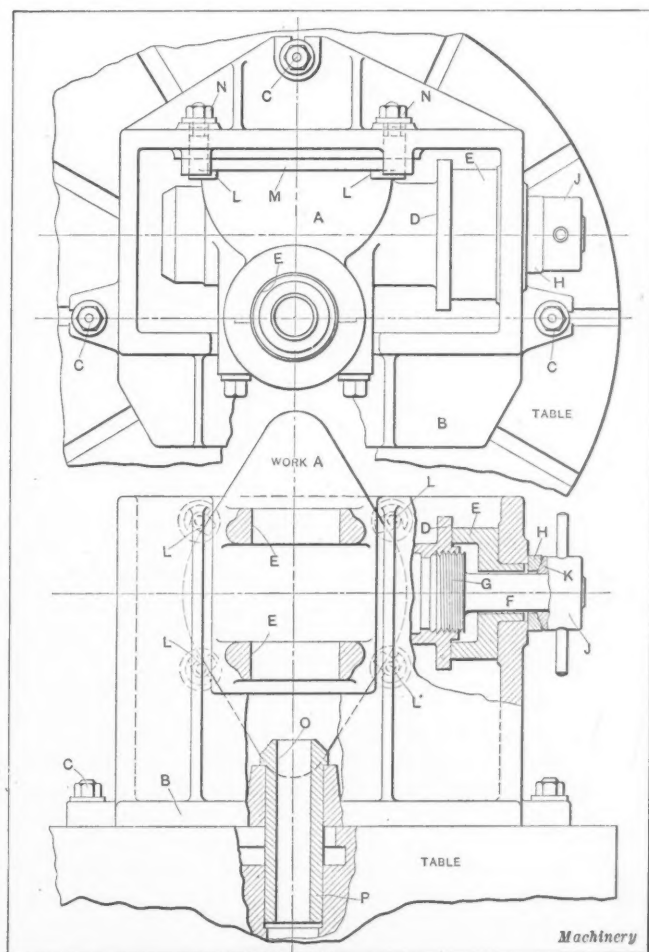


Fig. 11. Fixture with Floating Locators to take Care of Two Finished Surfaces

Two-jaw Chuck Arranged with a Floating Jaw

The work *A* shown in Fig. 6 is a motorcycle flywheel which it was desired to machine in one setting complete. The machine to which the equipment was applied was a horizontal turret lathe. Several lugs on the interior of the casting made the matter of holding the work in a three-jaw chuck out of the question on account of interferences with the jaws. A two-jaw chuck was therefore utilized, and interferences thereby avoided. As the centering action of a chuck of this type is very uncertain when used for holding work by an interior surface of comparatively large diameter, some method of locating was necessary which would at the same time center the casting, and yet not cause trouble by interfering with the lugs on the interior of the flywheel. (The lugs on the interior of the casting are not shown in the illustration, in order to avoid confusion.)

The chuck body *B* is screwed to the spindle *C* in the usual manner and is provided with two special jaws, one of which, *E*, is of plain design having two bearing surfaces on the inner rim of the flywheel casting. The other, *D*, is grooved to fit the chuck like the regular jaw, but is very much wider as it comes above the face of the chuck. This portion is turned to a radius at *H* and given an angle of 10 degrees at the same time in order to counteract the lifting tendency which might cause trouble when the jaws were tightened. The floating member or "rocker" *F* is mounted on this jaw as shown in the illustration, and is limited in its movement by the two screws *G* and the elongated holes in the rocker. This construction gives a very good centering action, and the rocker jaw has sufficient "float" to take care of variations in the casting.

Piston Chuck Having Floating Clamping Features

The work *A* shown in Fig. 8 is a large automobile piston which has been bored and faced on the open end to a predetermined size and which is to be completed in this setting, concentric and square with the finished portion. Previous to this setting and after the boring and facing operation, the wrist-pin hole is rough-drilled in a jig in order to facilitate the holding of the work on the fixture.

The casting is located on a hardened and ground steel ring *F* which is forced onto the body of the fixture *B*, and a small annular groove on the ring prevents trouble or errors in locating, which might be caused by the presence of chips or dirt on the locating surface. The body of the fixture is held in place on the table of the machine by the bolts *C* which enter the table tee-slots, and it is centered on the table by the plug *D* which is forced into it at *S*. The clamping pin *L* is ball ended, and has a spherical portion in the center also. It is slotted at *N* so that the pin *M* in the draw-bar *G* will enter the slot as it is passed through the wrist-pin holes, and bring up against the shoulder so as to center the clamping pin in the piston. A great deal of strain is taken by this clamping pin, and for this reason it is made of tool steel and spring tempered, so that there will be less chance of breakage.

The draw-bar *G* is also of tool steel, and it is keyed with a Woodruff key at *H* to prevent its turning, the key being a

sliding fit in the body of the fixture. The lower end of the rod is threaded with a 4-pitch Acme thread, double, left-hand, to fit the operating nut *Q*, this latter being provided with a handle *R* which extends out through a cored opening *O* in the fixture. The permissible movement of this handle is sufficient to produce a vertical movement of 3/16 inch of the draw-bar, which is ample for the purpose of clamping and releasing. A thrust collar *P* is interposed between the operating nut and the boss on the under side of the fixture, and a coil spring *J* keeps the rod up so that the clamping pin may be easily placed in position. The pocket *E* in the upper end of the centering plug is for clearance only. A heavy pin *K* acts as a driver against one of the wrist-pin bosses, so that the draw-rod and pin are not called upon to perform this part of the work.

It will be noted that while this chucking device is very rapid in its operation, there is no tendency to "cock" the piston or distort it in any way, as the floating action of the pin with its three-point bearing equalizes all pressures, and at the same time provides a very secure method of clamping the work.

Chuck Jaws with Floating Locating Points

The work *A* shown in Fig. 9 is to be bored, shouldered and faced complete in one setting, and on account of its length it was considered necessary to provide additional supporting points besides the jaw surfaces. A set of special jaws *B* is keyed to the sub-jaws in the table at *D*, each special jaw being shouldered at *C* to support the work.

The brackets *E* are tongued at *F* to fit the special jaws and are secured thereto by the screws *G*. These brackets act as a support for the steel floating ring *M* in which the three spring-pins *J* are placed. Elongated holes at points *N* allow the required floating action, the ring being clamped by the collar-head screws. The brackets on which the ring rests are provided with a shelf *H* which is offset slightly from the center so as to give the necessary width for the screws. In using the device, the screws *L* and *N*

are loosened, and the work placed in the jaws, which are then tightened while the ring floats sufficiently to allow for variations. It will be noted that the pins, being spring-controlled, adapt themselves to the casting and are there locked by the screws *L*, after which the ring itself is clamped by the collar-head screws *N*.

Although the floating action of this device was satisfactory, the driving or gripping power was found insufficient to hold the work securely, and it became necessary to replace the spring pins with square-head set-screws, cup-pointed, the ring being tapped out to receive them. The ring was then allowed to float while these screws were lightly set up on the work, after which the clamping screws *N* were tightened. After this change in construction, the action of the mechanism was much improved, and the driving power was found sufficient.

Roughing Out Fixture for Motor Gear

A very unusual condition is shown in Fig. 10, as the work *A* is a steel forging which is to be roughed out all over within limits of 1/8 inch plus or minus. After the roughing opera-

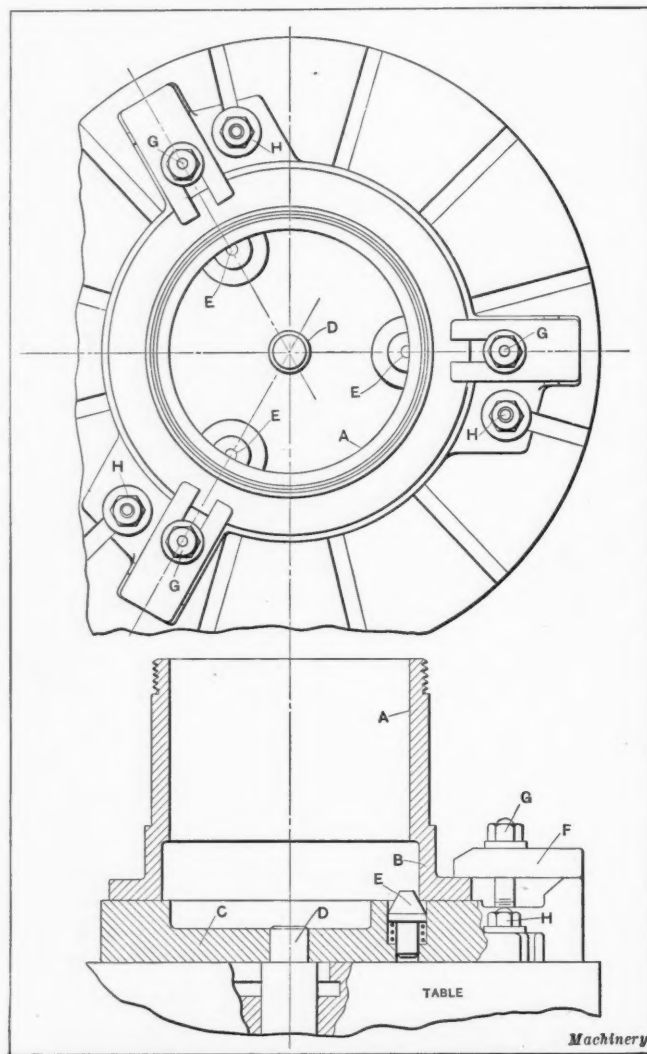


Fig. 12. Fixture with Floating Locating Points

tions, the work was machined (all except the web) to the required dimensions, other fixtures being used for the finishing operations.

The amount of metal to be removed was considerable so that it was necessary to provide a good means of driving the work in order that no slippage might occur, due to the pressure of the cut. A fixture *C* is centered on the table by the stud *E* which is turned down at *F* to a size small enough to enter the hole in the hub. The three bolts *D* are used to hold the fixture down on the table, the table tee-slots being utilized for the purpose. Three studs *B*, which are of tool steel with conical hardened ends, serve as locating points and drivers for the hub of the forging. The floating collar *G* has a concave surface on which the special nut *J* bears, and it is provided with a three-point bearing on its under side to equalize variations in the end of the hub, as shown at *H* in the illustration. As the diameter of the hub is somewhat small, it is evident that the amount of driving surface accessible at this point would be insufficient for heavy cuts to be taken. As an additional precaution, the threaded bushings *L* are set in the body of the fixture and are provided with the screws *K* which are cone-pointed and of hardened tool steel. These screws are set up into the rim of the forging to assist in the driving.

Fixture with Floating Locators to take Care of Two Finished Surfaces

It is occasionally necessary to make up a fixture in such a way that it will locate a piece of work correctly from two finished surfaces in different planes. An example of this kind is shown in Fig. 11, which is an automobile housing, surface-milled at *M* and faced and threaded on the flange *D*. It is necessary to locate the work from these two surfaces in order to bore the bearings *E*. The fixture *B* is located on the table by the centering bushing *P* which is of tool steel hardened and ground and which acts as a guide at *O* for the pilots of the boring tools which are used in machining the work.

The work is placed in the fixture with the finished flange *M* against the pad and is held in place against this surface by the four hook-bolts *L*, the nuts *N* being used to draw them up tightly. A screw plug *G* enters the threaded end of the flange *D*, and the shank *F* passes through the bushing *E* and obtains a spherical bearing at *K* on the floating washer *H*, clearance being provided in the enlarged hole in the bushing so that slight inequalities both in the alignment of the thread and the surface of the flange will be equalized by the floating action. The collar *J* is provided with a handle by which the screw may be operated. The nature of this work is such that the accuracy required is compensated for by this method of locating.

Fixture with Floating Locating Points

We sometimes learn more by the observance of mistakes in design than we do by those which are perfectly satisfactory. An example of a fixture which was incorrect in design and which did not give satisfactory results is shown in Fig. 12. In this case the work *A* is a large cast-iron pot which is located on the cored interior surface *B* by the three conical spring points *E*, these points being so designed that they will approximate the center of the cored surface. The fixture

C is centered on the table by the plug *D* and is held down by the three bolts *H* which enter the table tee-slots. Three clamps *F* are slotted at their inner end to allow a rapid withdrawal and are clamped down upon the rim of the work by the nuts and washers at *G*.

The principal fault in this device was the fact that although the conical points *E* permitted a floating action, there was nothing to prevent any one of these points being forced downward more than the others so that there was naturally a tendency toward faulty locating, caused by the unequal distribution of pressure on these points. A single spring plug having three points of location would undoubtedly be more satisfactory, for then the pressure would be more evenly distributed.

Fixture with a Floating Threaded Locator

Fig. 13 shows a piece of work *A* which has been previously faced and threaded. Six holes have also been drilled in the flange, one of which is used for driving through the medium of the pin *C*. The fixture *D* is of cast iron, located on the table by the plug *O* which is centered in the fixture *F* and is held down by the bolts *E* in the usual manner. The work itself locates on the fixture by the shoulder portion *B* and is driven by the pin *C* in one of the flange holes. In order to equalize any variation between the faced surface and the threaded portion the floating threaded plug *G* is provided with a spherical collar *M* at its lower end, this collar being pinned to it by the pin *N*. The floating collar *L* also has a spherical bearing which matches that of the collar *M*. Sufficient clearance is provided in the body of the fixture to allow the plug to float in any direction. A spring *H* keeps the threaded plug up in its proper position. A socket wrench *K*, squared at *J*, is provided for drawing the threaded plug up into the work.

Grinding Fixture for a Steel Collar

The work *A* shown in Fig. 14 is a steel casting which is to be ground on the two exterior surfaces. A nose piece *D* is screwed to the end of the spindle *E* and is provided with a hardened and ground lo-

cating ring *B* on which the work locates. The stud *C* is forced into the nose piece and is threaded on its outer end to receive a spherical nut *F*. The collar *G* is concaved to the same radius as the spherical portion of the nut so that it floats against the end of the work.

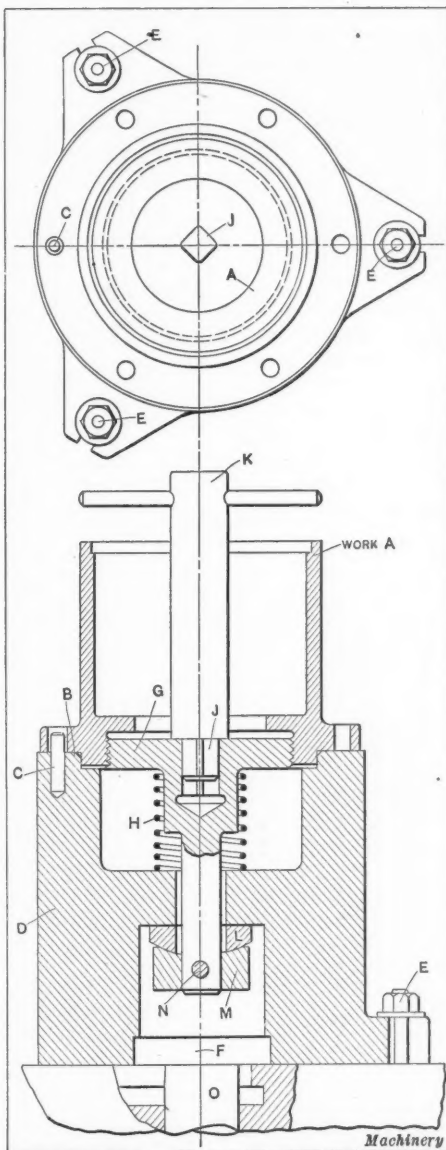


Fig. 13. Fixture with a Floating Threaded Locator

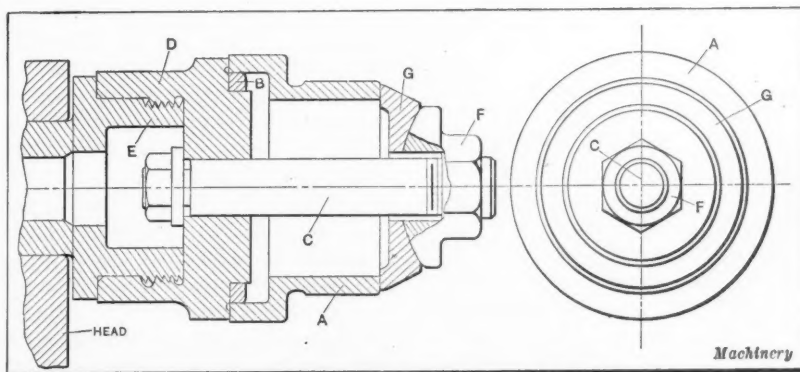


Fig. 14. Grinding Fixture for Steel Collars

THE VALUATION OF MACHINE TOOLS*

FUNDAMENTAL PRINCIPLES GOVERNING THE MAKING OF AN ACCURATE APPRAISAL

BY GEORGE L. COLBURN†

As soon as a machine is installed and ready for operation, it begins to depreciate in value. This depreciation takes place at a variable rate and is more or less compensated for by repairs and renewals. But although depreciation takes place at a variable rate, an average can be determined by estimating the probable working life of the machine and then distributing over this period the difference between the cost of the machine and its junk value. The cost of the machine includes the original price, the expense of installation, the cost of all repairs and renewals, and the expenditure for special tools and fixtures. The installation expense includes the cost of freight, carting, millwright material and labor. The junk value of the machine is the net value received for the old metal in it after making the proper deduction for the expense of dismantling the machine, preparing the junk for shipment, carting and all other incidental expenses. For example, suppose it is required to determine the average depreciation per year of an engine lathe, which originally cost \$500, and for which the working life is estimated at twenty years. The installation cost was \$65; the total cost of repairs, renewals, and special tools and fixtures is estimated at \$100; and the junk value is approximately \$5. The depreciation per year will be:

$$\frac{500 + 65 + 100 - 5}{20} = \frac{660}{20} = \$33.$$

$$\frac{33}{660} \times 100 = 5 \text{ per cent.}$$

An average depreciation arrived at in this way is generally found more convenient for purposes of accounting than the use of figures obtained from annual appraisals of the plant. Some firms establish an average annual rate of depreciation on all machine tools, this rate being not far from 5 per cent; but very cautious concerns allow as much as 10 per cent for the annual rate of depreciation on all machinery in the plant. The preceding method of figuring the average depreciation rate on individual machine tools is more accurate than any general average is likely to be, although it requires more time from the cost clerks and the expense of additional bookkeeping. The office records of mechanical equipment should show the original price of each machine; the date of purchase; the name and address of the builder; and the cost of installation, repairs and renewals, and special tools and fixtures.

In figuring an average rate of depreciation for a given machine, the probable cost of special tools and fixtures is difficult to estimate in advance, but this part of the work is greatly simplified when the builder of the machine has a listed stock of such tools and fixtures from which the purchaser can select those which are necessary for handling his work. The probable working life of the machine and the cost of repairs and renewals naturally depend upon the care which the machine receives, the number of hours it is used per day and the character of the work for which it is used. In estimating the probable life of a machine and the cost of repairs, renewals and special tools and fixtures, the cost clerk could be greatly assisted by a factory committee consisting of the superintendent and foremen of departments, including the repair foreman. It is customary in most factories to take an annual inventory of stock, supplies, small tools, machinery, furniture and fixed plant. Then by reference to the records of the purchasing and bookkeeping departments, data is available which may be used in connection with the predetermined rates of depreciation to enable the cost clerks to place inventory values on all items.

Machine Tool Appraisals

As a check on the cost clerk's work, it is advisable for the factory manager or some other official who is acquainted with the technical details of the equipment to annually ap-

praise the value of the machinery and fixed plant. In making such an appraisal it would be of great assistance to have each machine provided with a nameplate giving its inventory number, the date when it was built and the name and address of the manufacturer. Whenever there is any doubt about the value which should be placed upon a machine tool, the office records should be consulted to determine the original price, the installation expense and the cost of repairs, renewals, and special tools and fixtures. Additional information may often be obtained by consulting the foreman of the department in which the machine is used and the repair foreman. An appraisal of machine tools conducted by a factory official should be thoroughly and scientifically carried out without reference to the tax and insurance rates or the relation of dividends to capital invested.

In order to obtain a thoroughly impartial appraisal, or as a check on their own method of valuation, many firms employ an expert appraiser to place a value on their furniture, supplies, small tools, machinery and fixed plant. Some appraisers also place a value on stock, but as a rule manufacturers prefer to fix their own value on this item. Among the numerous factors which such an expert appraiser has to consider before being able to place an accurate value upon a machine tool, the following may be mentioned: productive efficiency of the machine, original price, expense of installation, cost of repairs and renewals, investment in special tools and fixtures, and the probable working life of the machine.

Productive Efficiency of a Machine

The productive efficiency of a machine, or the ratio of its actual output to the maximum output, is the real basis in fixing its value in dollars and cents. Many conditions exert an influence in fixing this productive efficiency. For instance, a low efficiency may be due to an insufficient supply of stock, lack of skill on the part of the operator, lack of power or operation at too slow a speed; and it will be noted that the builder of the machine is in no way responsible for any of these causes of poor efficiency. The appraised value of a machine tool is not necessarily affected by such conditions, the points of cardinal importance in fixing its value being the actual condition of the machine itself, such as the style; age; state of repair and rate of production under the most favorable conditions, as compared to that of a similar machine of the most modern design.

Original Price, Installation Expense and Final Junk Value

The maximum value of a machine is the current price of a similar machine that is available for immediate delivery plus the expense of installation. The final junk value is the net price which can be obtained for the materials in the machine after deducting the expense of dismantling the machine and preparing the junk for shipment.

Additions, Attachments and Tools

Additions or improvements in the design of various parts of a machine are frequently made in order to accomplish certain results, and the cost of such additions should be included in fixing the appraised value of the machine. The number, size and condition of each machine and its special attachments and tools, i.e., whether in good, fair or poor condition, should be stated in the inventory in addition to giving the appraised value.

Repairs and Renewals

Through continued use the working parts of a machine necessarily experience a certain amount of wear and tear, which requires the making of repairs and renewals from time to time. The lack of a proper foundation, and the provision of insufficient metal in the frame or a poor distribution of this metal, will cause vibration and result in excessive wear and breakage of machine parts. A record of the cost of repairs and renewals should be carefully kept in the office for each individual machine, where it is available for use in connection with the fixing of appraised values.

Type of Machine and Probable Working Life

Machine tools are divided into the various familiar classes, such as engine lathes, milling machines, etc., and a further subdivision of these classes is made as plain, semi-automatic, full automatic, etc. Owing to the general use of high-speed

* See also "Modern Practice in Manufacturing Plant Appraisal," in MACHINERY for May, 1913.

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steel, machine tools are now designed and built to enable them to stand up under much greater speeds, feeds and depths of cut than was the case fifteen or twenty years ago. This change in the design of machine tools is also due to a desire on the part of manufacturers to get the maximum amount of work out of the machines, this increase in the rate of production being carried almost to the point where breaking or excessive wearing down of the cutting tools will occur. The employment of these high speeds, feeds and depths of cut, together with overtime work or the employment of night shifts, and lack of care in adjusting the machines, causes a great increase in wear and tear and a consequent reduction in the working life of the machines.

Obsolete Machines

A machine may become obsolete before it is worn out. Another point in the efficient conduct of a manufacturing plant is the possibility of using a machine for performing roughing operations, which has become too badly worn to enable it to give satisfaction in the production of accurate work, after which the finishing operations are performed on a newer machine which is in good working condition. Where the labor necessary to operate an old style or obsolete machine greatly exceeds that of a more modern machine for doing the same class of work, or where its output is of considerably poorer quality than that of the more modern equipment, the obsolete machine should be dispensed with even if it is necessary to sell it at its junk value.

Machines in an Idle Factory

Machines in an idle factory depreciate rapidly in value due to rusting, etc., from lack of care. Where the machines in a factory which has stopped running are offered for sale, those types which are commonly used in many trades find the best market, and this is particularly true of those machines built by well known machinery manufacturers. Auction sales of machinery conducted under the direction of receivers of bankrupt concerns often bring high prices owing to the demand which may exist for machines for immediate delivery.

Fire Damage

Indemnity and not reinstatement is the principle on which fire insurance claims are usually settled, although insurance companies reserve the right of replacing the equipment instead of paying cash if the estimated loss is considered excessive. In the case of fires where the office records have been preserved, but where such records fail to show the original cost of the equipment, its age and probable depreciation, outside proofs of the original cost are generally secured from the dealers or manufacturers from which the equipment was purchased. When the machinery loss represents a considerable amount, the insurance companies often secure the services of a recognized expert appraiser, and in case a dispute arises arbitration is resorted to, the representatives of the insurance company and the assured conferring with a third expert appraiser obtained by them; and the agreement of any two members of this trio is accepted as final.

An appraisal made before a fire by a reliable expert appraiser is of great help in the settlement of a fire loss, but the results of such an appraisal are not always accepted by the insurance companies. Stock insurance companies generally state in their policies that in case the aggregate claim for any loss does not exceed 5 per cent of the total value, no special inventory or appraisal of the undamaged property shall be required of the assured. Insurance companies pay the actual value at the time of the fire of the equipment damaged by the fire, which is not the full value unless a total loss occurs. In case of a total loss, the cost of the removal of the debris is also included. With the factory mutual fire insurance companies, the equipment is appraised in advance by experts employed by the insurance companies, and standard rates of depreciation are adopted for various classes of machinery. The following items are usually recorded by the mutual companies: the number and name of the factory; the name of the appraiser who made the inventory; the date on which the inventory was made; the type of building in which the plant is housed; the location of each department in the plant; and a description of each unit of equipment including the builder, the date built, the present cost of a similar

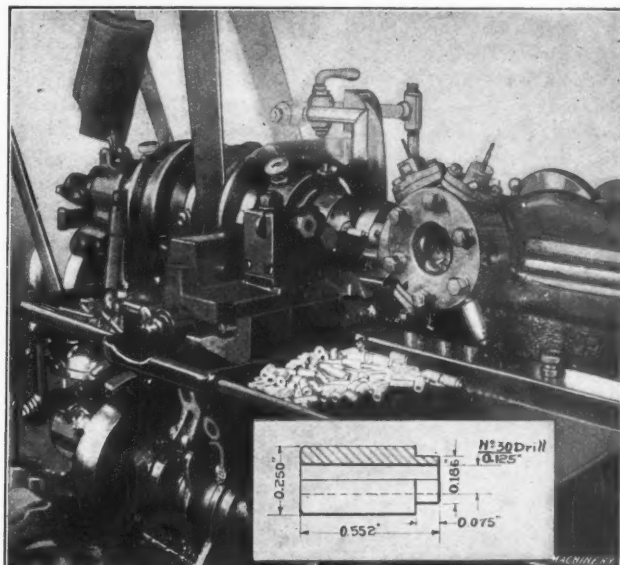
new machine, the cost of installation, the rate of depreciation on that class of machine and the approximate net value. With such information available, the settlement of fire losses becomes a relatively simple matter, as definite information is available covering all points which have a bearing upon the conditions which govern the making of a settlement.

* * *

A RECORD TEST ON SMALL DRILLS

Drilling deep holes in the automatic screw machine is a difficult proposition because of the fact that the drills generally become dull quickly and do not produce a straight hole in the work, or else the drill breaks. Even under the most favorable circumstances, it is difficult to produce a straight hole of any depth with one drill, and the general practice is to use one or more drills in the turret and only drill a short distance—from two to five times the diameter of the drill—until the full depth of the hole has been reached.

An interesting experiment with small drills was lately made in the plant of the Atlantic Mfg. Co., Bridgeport, Conn., on a No. 00 Brown & Sharpe automatic screw machine. The stock being drilled was 17/64 inch cold-rolled steel, which was rotated at a speed of 2600 R. P. M. The depth of the hole in the piece, as shown by the illustration, was 5/8 inch, and the diameter of the drilled hole was No. 30—0.125 inch. The drills which were found to give the best results were those made by the Detroit Twist Drill Co., Detroit, Mich. Four of these Detroit high-speed drills, as shown, were held in the turret in standard Brown & Sharpe floating holders. The first, which acted as a center drill, was fed in to a depth of 0.187 inch, at a feed of 0.005 inch per revolution of the work. The second drill was fed in to a depth of 0.312 inch, at a feed of 0.005 inch per revolution of the work. The third



No. 00 Brown & Sharpe Automatic Screw Machine on which the Drilling Test was made

drill was fed in to a depth of 0.070 inch, at a feed of 0.003 inch per revolution of the work, while the fourth drill was fed in to a depth of 0.070 inch at a feed of 0.003 inch per revolution of the work.

It will be noticed in looking over this list that the second drill was fed in a much greater distance than the last two drills. The reason for this is that as the depth increases, greater difficulty is met with in getting rid of the chips, and the feed must be decreased as the depth increases to secure a straight hole. A most remarkable feature about this test was the length of time that the drills stood up without re-grinding. The machine was stopped after 50,000 pieces had been turned out and the drills were still in good condition. It was also found that the most severe duty came on the drill that penetrated 0.312 inch into the work, as would reasonably be expected.

D. T. H.

* * *

At least two automobile builders are planning to bring out eight-cylinder cars as their 1915 models. These two makers have, in the past, built only four-cylinder cars.

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WHEN THE WAR ENDS

In spite of the commercialism of which we have been justly accused, the thoughts of all men in our favored and happy country turn with longing toward the dawn of peace. But we fear peace will not come with the summer as some sanguine authorities foretell, because many great changes must come first. If the war is to end with victory for the allies, Belgium, the part of France held by the Germans, and Alsace and Lorraine, must first be reconquered, foot by foot. To realize what is involved in that task, remember the cost of the last ten-mile advance.

The longer the war continues, the more gradual will be the reduction in demand for machine tools used in the production of war material; and this condition should avert the danger of a sudden and wholesale cancellation of orders which some manufacturers fear. With peace will come a period of world-wide readjustment, and manufacturers who are tempted to over-extend by the present clamorous demand should consider what its cessation will mean to them.

To forecast our own commercial future after the close of the war is an undertaking the wisest would turn from. That the hundreds of millions disbursed in this country for war orders will partly offset the loss of manufactured exports is a hopeful fact. Some results for Europe we can figure out with reasonable certainty—greatly diminished buying power, higher labor and material costs, increased living expenses, heavier taxes to support the burdens of debt, but added power to the people living under autocratic governments to determine for themselves the questions of life and death which heretofore have been decided for them by their rulers.

CARRYING OFF THE HEAT

The investigation of Taylor into the laws of cutting metals showed the importance of carrying off the heat from the point of the tool as quickly as possible. Separating the chip from the body and curling it requires the expenditure of energy, which is transformed into heat. The development of high-speed steel has greatly increased the efficiency of metal-cutting tools, and notwithstanding its high cost, high-speed steel has displaced carbon steel generally for lathe tools, twist drills, milling cutters and other typical metal-cutting tools. But the discovery of high-speed steel did not solve the problem of carrying off the heat generated; it provided

a cutting material that works efficiently at comparatively high temperatures. If the critical temperature is exceeded, the tool speedily breaks down.

There are various means of carrying off the heat and of reducing the amount generated. If a twist drill is ground so that the lips break the chips instead of curling them, the heat generated is lessened, but there is presented the difficulty of getting the chips out of the hole. Hence, the development of inverted drilling machines which let the chips fall out by gravity as soon as they are broken loose, using straight-fluted drills to facilitate clearing them from the point and breaking them up. Oil-tube drills also provide for cooling the cutting edges and ejecting the chips. Copious soda water streams on lathe tools reduce the temperature of the chip and permit increase of cutting speed.

But all these are palliatives that reduce but do not abate the deteriorating effect of heat generated at the extreme cutting point; buried in metal no liquid can reach it, lubrication being effective only at an appreciable distance from the point. Hence, the lubricating effect of cutting compounds is subordinate to their effect as cooling mediums after heat is generated. How can the efficiency of cooling mediums be increased?

The greatest need of better cooling in metal cutting is, perhaps, in grinding. The heat generated does not appreciably affect the wheel, but it distorts and injures the metal, especially if hardened. A fruitful field for scientific study is that of grinding with a minimum of heat generated and the rapid withdrawal from the work of the heat unavoidably produced. The investigation should result in a great improvement in grinding practice.

* * *

THE NARROW GUIDE

In many machine tools, guides are provided only at the outer edges of wide carriages. In order to permit the carriages or slides to move freely, it is necessary to allow a certain amount of looseness in the sliding fits, and this is often sufficient to change the alignment of the parts. If the feed-screw is at the front of the slide, far removed from the back guiding surface, there is also a tendency for the slide to bind. Observing these difficulties, machine tool builders have realized that the inaccuracy of alignment and the tendency to bind could be reduced to a minimum by making the guideways as narrow as practicable and as long as the character of the machine would permit. This type of guideway is generally referred to as the "narrow guide." Although the angle of deflection due to cross-winding is the same with wide as with narrow guides, other conditions being the same, the lateral pressure on the sides of the guide and slide is greater on a wide guide than on a narrow one, for any given eccentric load. Therefore the friction and wear are greater on wide guides than on narrow ones.

The advantages of the narrow guide are not obtained merely by having a guideway that is as narrow as possible, but depend mainly upon the correct location of the guideways. When a narrow guide is used, it must be arranged on the machine close to the resisting and feeding forces. A narrow guide strip at the back of a carriage having a feed-screw in front would probably be more harmful than the ordinary wide guide. In machine tool construction where one vee and one flat are used, the vee, being in effect a narrow guide, must be nearer to the feeding force and the resistance.

When the narrow guide is placed near the feeding forces, however, its advantage lies in the reduction of the moment of the frictional resistance and, hence, of the required feeding force. Some advantages are also derived from the better mechanical construction possible with the narrow guide, since the guiding surfaces can generally be made very rigid.

When the feed- or lead-screws of machine tools are so placed that they are in close proximity to the narrow guide, there is no question as to this design being an improved means of guiding the tool-carrying head or slide of any machine, but it should be fully understood that it is not the narrow guide as such, but rather its position relative to the feeding force, that accounts for the advantages gained.

ON FINDING THE TRANSFORMATION POINTS IN STEEL*

APPARATUS FOR DETERMINING THE DECALESCENT AND RECALESCENT PARTS OF THE TEMPERATURE CURVE

BY E. F. LAKE†

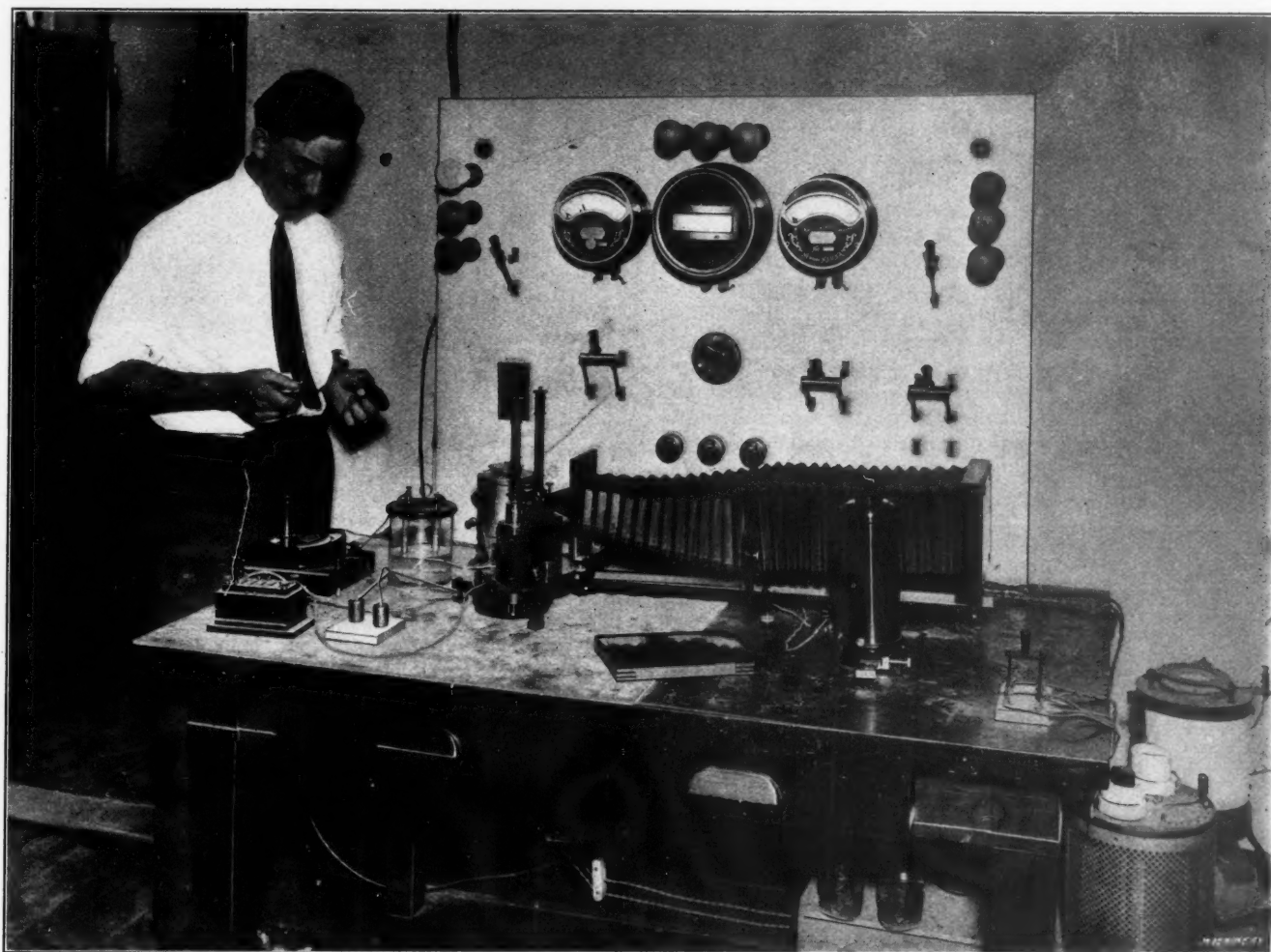


Fig. 1. Saladin Apparatus for determining Transformation Points in Steel, Iron, etc.

SO many improvements have been made in the heat-treatment of steel in the past few years that the temperatures should no longer be judged by color. Pyrometers and other heat measuring instruments have been brought into use which enable one to get the heat-treatment temperatures much more accurately than was ever done by the old eyesight method. The scientific investigators of the heat-treatment of steel have also laid down certain rules that can be followed to give very accurate results, and their investigations have shown that the variations in temperature by the old eyesight method resulted in considerable loss in the strength of the metal and in its resistance to fatigue.

The investigators discovered the fact that steels underwent certain transformations in their grain structure at definite degrees of temperatures; also that these transformation periods were of vital importance for obtaining the correct temperatures at which to heat-treat steels. In some steels there are several transformation points. The one that occurs at the highest temperature is the one that is very important for the annealing and hardening operations. At this temperature the molecules of the metal rearrange themselves in a manner that produces the finest and densest grain structure that the metal is capable of assuming. This also removes any internal strains that may have been set up in the metal by the mechanical working it received in the shaping operations. Lower transformation points are less important, but might be utilized when cooling the steel down or when preheating. Various other terms are used in place

of transformation to designate these same points. Some of these are critical, decalescent, recalescent, Ac., Ar, and transition. At the upper transformation point steel loses its magnetism but it returns again when the steel cools down past that point.

Before annealing or hardening, one should always find what is the highest transformation point of the steel he is using and then regulate the furnaces so the metal can be heated to just above this temperature. Various ways and means have been devised for obtaining this transformation point. Some use quite complicated apparatus for definitely deciding the exact degree of temperature at which this transformation takes place. With such apparatus it might be located within one-quarter degree of the correct point, but for many kinds of commercial work this is like splitting hairs. Then a much simpler outfit can be used that indicates within ten degrees of the exact temperature at which the transformation occurs.

On large work one cannot expect to get the accuracy obtained on small work. When steel is heated in large furnaces it is almost impossible to keep the heating chamber within twenty-five degrees of the desired temperature. Then it would seem useless and impractical to have an accuracy of one-quarter degree in the location of the transformation point. The cheaper outfits that indicate within ten degrees of the correct temperature are all that are required for such commercial work. At present there are many small furnaces in use that vary twenty-five degrees or more in the heating chamber, but the accurate temperature furnaces now built seldom vary more than ten degrees. Temperature control instruments can be attached that automatically keep the furnace temperature within five degrees of any given point.

* For additional information on determining the transformation points of steel see "Locating the Critical Range with the Brinell Ball Tester," December, 1914; "Hardening Carbon Steels," January, 1910; "Recalescence and Its Relation to Hardening," October, 1909; and MACHINERY's Reference Book No. 63, "Heat-treatment of Steel."

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For the smaller steel parts which are annealed or hardened in these furnaces, the more accurate apparatus can be utilized. Its importance can be seen when one realizes that each degree to which steel is heated above the transformation point adds to the coarseness of the grain structure and weakens the steel in like proportion. It might then be good business policy to use the more elaborate and costly outfits in order to heat-treat steels so they will have the maximum amount of strength that they are capable of attaining and also the greatest wearing qualities and longevity.

One of the most accurate outfits made for determining the transformation point of steel, iron, etc., is the Saladin apparatus made by Siemens & Halske in Berlin. This is shown in Fig. 1 as it is being marketed by Charles Engelhard of New York at an approximate price of \$500.

It employs two Deprez d'Arsonval type mirror galvanometers which are optically coupled by mirrors and prisms. One gives a horizontal and the other a vertical movement to the beam of light which comes from a lantern containing a Nernst lamp. This combination of vertical deflection with horizontal deviation produces a curve on a photographic plate in the camera attachment as the temperature of the steel is being raised through the transformation point. A differential thermo-couple is used with two platinum arms thirty-six inches long and one platinum-rhodium arm twenty-

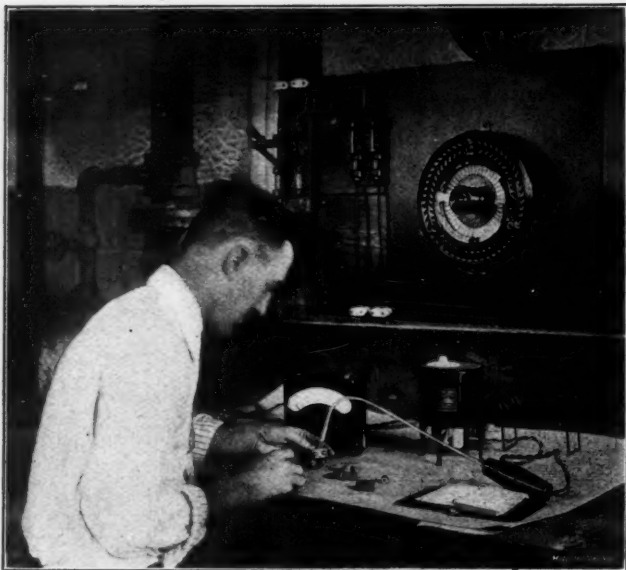


Fig. 2. Hoskins Recalescence Outfit

four inches long. The transformation point can be visually determined by using a differential galvanometer that is supplied as an extra. This has the zero point in the center with 1.2 millivolt deflection on both sides.

An accuracy of less than one degree F. is obtained with this apparatus. While it was originally designed for college laboratories it is now being used by some shops. The arguments used in its favor are: If we start with a ten-degree variation in the determination of the transformation point, then have a variation of ten degrees or more in the furnace, another variation due to the operator's judgment and other inaccuracies from other causes, we may soon be 50 or 100 degrees out. Then one may get so far away from the actual transformation point that it makes considerable difference in the quality of the part that is being heat-treated. However that may be, where great accuracy is desired and cost is not a factor, this apparatus will doubtless give the desired results.

In annealing steels the three rules that should be used are as follows:

1. The steel must be heated to a temperature above the highest transformation point of the steel, but as close to this point as possible.
2. This temperature must be retained long enough to allow the entire piece to reach an even temperature, but it should not be prolonged beyond that.
3. The rate of cooling must be slow enough to prevent any hardening taking place, even superficial hardening.

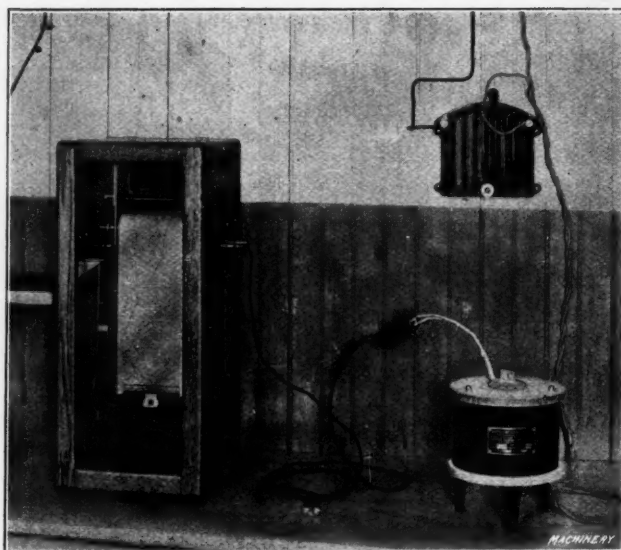


Fig. 3. Thwing's Equipment for determining Critical Temperatures in Metals

To harden steel these same rules apply except that Rule 3 is reversed. That is, the steel must be suddenly cooled or quenched instead of slowly cooled.

This shows the necessity of knowing the highest transformation point of any steel before attempting to heat-treat it in any way. The temperature at which this transformation occurs is different in different grades of steel, the variation being caused by the different elements that enter into its composition. With the proper apparatus it is only the work of a few minutes to find the transformation point. Thus one can be more positive of results if it is obtained on each batch of steel before it is annealed or hardened.

One of the more simple outfits is that shown in Fig. 2, made by the Hoskins Mfg. Co. of Detroit, Mich. This consists of a Hoskins stock pyrometer, a Hoskins small electric furnace and a rheostat. This outfit can be installed at an approximate cost of \$100. The rheostat makes it easier to control the temperature in the furnace, but it can be used without the rheostat. Then the cost would be about \$75. The electric furnace is not a necessity, as the pyrometer can be carried to any of the shop furnaces and the same results ob-

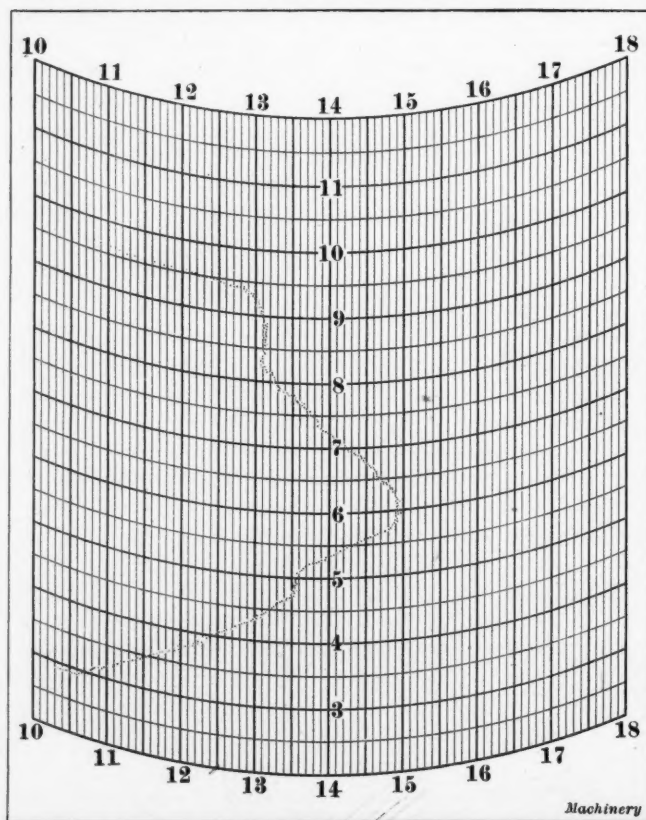


Fig. 4. Chart from Thwing Instrument showing Curve with Transformation Point

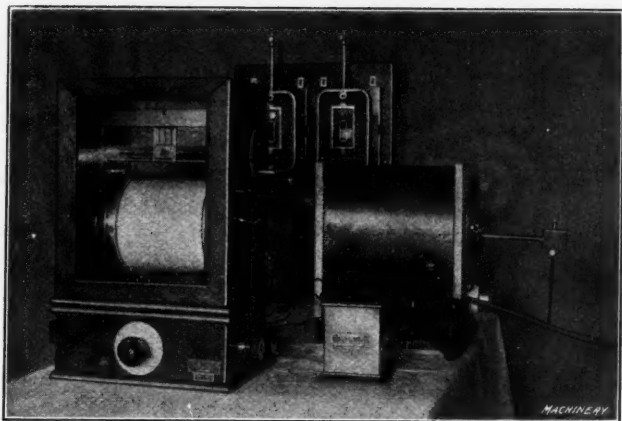


Fig. 5. Leeds & Northrup Apparatus for obtaining Transformation Points

tained. Then the pyrometer only is required, at a cost of about \$50. A recording chart instrument can be used in place of the galvanometer, at an extra cost, if one so desires. A curve of the rise and fall of the temperature of the steel will then be scribed on the chart and the transformation point will be shown by a crook in the curve.

In Fig. 2 the operator is shown clamping two pieces of steel, of which the transformation point is desired, to the end of the thermo-couple. After that they are inserted in the electric furnace, and as the temperature rises the readings are taken from the galvanometer. Each rise of twenty-five degrees can then be timed until the highest transformation point has been passed. When the transformation point is reached the galvanometer will not show further rise in temperature until the internal change has been completed in every grain of the steel being heated. After that, the temperature rises about as fast as it did before. Thus it takes a much longer time to pass through the twenty-five degrees in which the transformation takes place than it does through any other twenty-five degrees. Often this period is four or five times as long, and while the galvanometer pointer is stationary a reading can be taken that will be within five degrees of the correct one. Usually each rise of twenty-five degrees will take from fifteen to twenty seconds until the transformation occurs and then from one to three minutes is consumed before the temperature will go above that particular twenty-five degrees. In the table is shown the time as it was taken down in one of these operations. In this specimen the transformation took place at 1465 degrees. The pointer hesitated for nearly two minutes at that temperature.

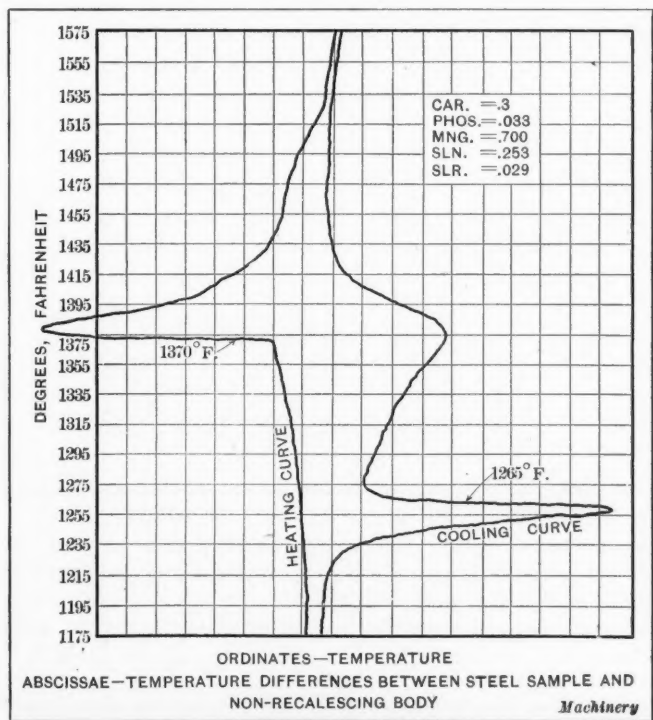


Fig. 6. Transformation Point Curves on Chart of Leeds & Northrup Instrument

TIMING RISE IN TEMPERATURE TO ASCERTAIN THE TRANSFORMATION POINT

Degrees F	Time of Rise in Temp., Seconds	Degrees F	Time of Rise in Temp., Seconds
1100 to 1125	15	1350 to 1375	16
1125 to 1150	17	1375 to 1400	18
1150 to 1175	15	1400 to 1425	17
1175 to 1200	16	1425 to 1450	23
1200 to 1225	14	1450 to 1475	115
1225 to 1250	15	1475 to 1500	32
1250 to 1275	17	1500 to 1525	20
1275 to 1300	16	1525 to 1550	19
1300 to 1325	17	1550 to 1575	20
1325 to 1350	18	1575 to 1600	22

Machinery

In Fig. 3 is shown an outfit marketed by the Thwing Instrument Co. of Philadelphia. In this case the recording chart instrument is used instead of the galvanometer. Like other companies, it gives the buyer the choice of having the galvanometer for optical determination or its capillary film recorder which scribes a curve on the chart. These can be used together if so desired. In this view, the steel specimen has been inserted in the furnace, to be heated.

If the specimen is large enough a hole is drilled in which the thermo-couple is inserted, instead of clamping the two pieces together over the thermo-couple end, as shown in Fig. 2. A small size of thermo-couple is made especially for these

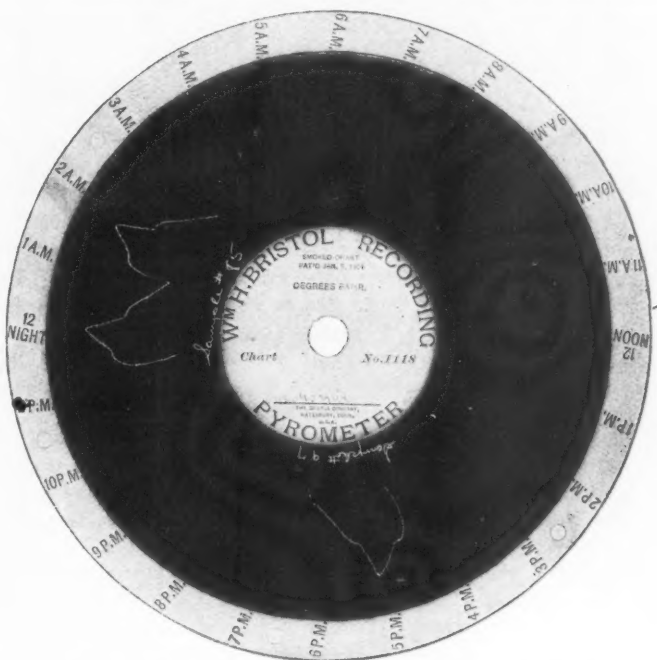


Fig. 7. Smoked Chart used by the Bristol Co. with Curves showing Critical Points

transformation point outfits and the hole in the steel need not be very large. The trouble of timing each rise of twenty-five degrees in the steel is done away with when the recording chart is used.

One of the charts on which a curve has been scribed is shown in Fig. 4. The large figures, 10 to 18, on the curved lines of the chart are for hundreds of degrees F. The figures 3 to 10, along the central vertical line, are for the time of the chart's travel. The curve is made by burning small holes through the chart by means of an electric current which passes through a needle in the end of the pointer that indicates the temperature. The lines crossing the chart are curved to compensate for the swing of this pointer.

While the temperature of the steel was rising the lower part of the curve was scribed. It will be seen that this curve formed nearly a perfect arc until it reached a temperature of 1355 degrees. Then the pointer which indicates the temperature remained stationary while the chart was traveling. This accounts for the crook in the curve, which plainly shows where the steel underwent its transformation. After that, the temperature of the steel was raised to 1490 degrees and the curve formed the same regular arc that it did before the steel passed through the transformation period.

The upper part of the curve shows how the steel cooled down. On cooling there was the same transformation phenomena, but it occurred at a temperature of 1310 degrees. This is some forty-five degrees below the point where it occurred when the temperature was being raised. The same thing occurs with most steels, and there is often a difference of more than 100 degrees.

It is the transformation point on the rising curve that is important, as the temperature of steel has to be raised in order to get it hot enough to be properly annealed. It will

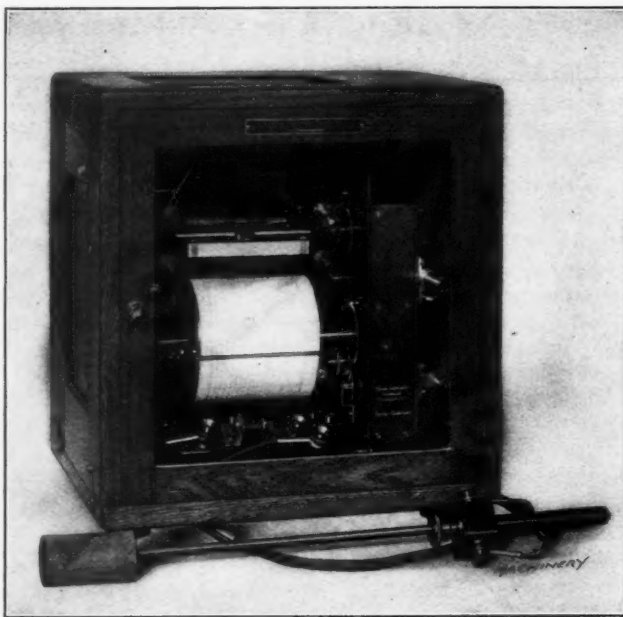


Fig. 8. Recording Chart Instrument made by the Taylor Instrument Co.

not harden or cannot be thoroughly annealed until this transformation has taken place in the grain structure. Thus this particular steel should be heated to about 1380 degrees to be assured that the transformation has taken place. When quenching steel to harden it, this would also take care of any lag that might occur between the time it leaves the furnace and is cooled to atmospheric temperature.

The speed at which the chart travels can be altered to suit conditions when scribing the curve. In this case it is traveling at the rate of $\frac{1}{8}$ inch per minute, or $7\frac{1}{2}$ inches per hour.

For this record it will be seen that, on the rising temperature, the chart traveled $\frac{3}{16}$ inch while the transformation was taking place. Then the steel did not show any change in temperature. This would represent a time of $1\frac{1}{2}$ minute. A rise of from fifty to seventy-five degrees took place during the same lapse of time in any other part of the curve. On the falling temperature it took more than three minutes to pass through this transformation period. Some of the alloy steels do not show such decided crooks in the curve, as their transformation is not so intense. This is especially so of high-speed steels.

In Fig. 5 is shown the recording chart apparatus which is made by the Leeds & Northrup Co. of Philadelphia. Here the electric furnace is placed horizontally and the rheostat is located underneath. The location is of no importance, however. The chart is also placed in the horizontal position. The pointer that indicates the temperature travels back and forth across the chart, instead of swinging like a pendulum. It scribes the curves with colored ink.

The method employed with this apparatus is to heat two bodies together in the same furnace, one being the steel under test and the other being a body which will heat uniformly without undergoing any changes. If their contact is sufficiently close they will remain equal in temperature while their temperature is being raised or lowered until the transformation begins to take place in the steel sample. Then this internal change involves an absorption or liberation of heat and a temperature difference is set up between the two. The curve on the chart records the difference in temperature between the two bodies being heated. Thus the transformation point of the steel is clearly shown.

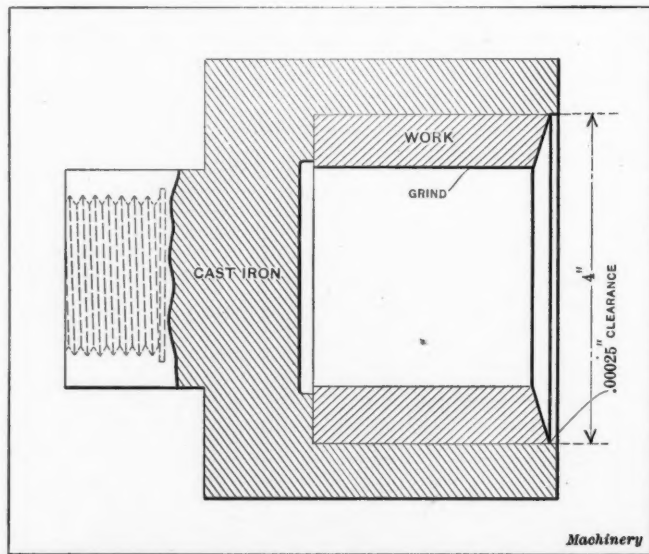
In Fig. 6 is shown the curve scribed on one of these charts when the transformation point was being determined. The composition of the steel is shown in the upper right-hand corner. The curve for the rising temperature is shown to the left of the chart and that of the falling temperature to the right. It will be seen that the transformation took place at 1370 degrees F. on the rising temperature and at about 1265 degrees on the falling temperature. Determinations of an inaccuracy of not more than five degrees can be made with this outfit. As this is as close as any shop furnace can be operated, it is close enough for any kind of commercial work unless it should be parts similar to the hair-springs of watches.

Another style of chart is that used by the Bristol Co. of Waterbury, Conn., as shown in Fig. 7. This is a circular disk that revolves like the hands of a clock, while the pointer that indicates the temperature travels in and out from the center. It is called the smoked chart, as its surface is covered with lampblack. The temperature indicating pointer scratches through the lampblack, leaving a white line on the paper beneath. The transformation point on both the rising and falling temperatures will be plainly seen by the crooks on each side of the three curves. In Fig. 8 is shown still another style of instrument with a recording chart, manufactured by the Taylor Instrument Co., Rochester, N. Y.

HOLDING ROLLER BEARING RACES FOR INTERNAL GRINDING

A simple yet practical and efficient method of holding roller bearing races for internal grinding at the Railway Roller Bearing Co.'s factory in Syracuse, N. Y., is shown in the illustration. These races are first ground on the outside and it is then necessary to mount them on the internal grinder spindle for grinding the inside.

For this purpose they are held in the sleeve shown in the illustration, which is merely a cast-iron block held on the spindle and bored out 0.00025 inch larger in diameter than the external diameter of the sleeve to be ground. These sleeves are approximately 4 inches outside diameter with an inside diameter of $3\frac{1}{2}$ inches and a length of 3 inches. No clamping screws or bolts of any kind are used, it simply being necessary to slide the steel race into the socket and proceed with the grinding, which is done with the aid of a lubricant. If the work were ground dry, it would probably



Holding Work for Internal Grinding without using Clamps or Jaws

be necessary to have a smaller amount of play between the socket and sleeve. Contrary to what might be expected, there is not the slightest tendency for the race to slip or work out from the sleeve while the grinding is taking place.

C. L. L.

According to a pamphlet published by the New York Public Library, 487 books, pamphlets, magazine articles, etc., on oxy-acetylene welding have been published.

DISTANCE BETWEEN SHAFT BEARINGS*

EMPIRICAL FORMULAS WHICH TAKE INTO CONSIDERATION
THE SPEED AND EFFECT OF CENTRIFUGAL FORCE

BY B. D. PINKNEY†

It is desirable to obtain a satisfactory maximum distance between bearings for lineshafting, both from a standpoint of total journal friction and of economy. An examination of existing data on this subject shows that precautions for the speed of the shaft are not considered, notwithstanding the fact that a general formula to cover a range of speed possibilities is a mechanical necessity on account of the high speed of lineshafting in certain factories—notably textile factories—and also special cases of high-speed lineshafts often met with in practice, which are coming more and more into use. The generally accepted safe maximum deflection of shafting is 0.01 inch per foot of shaft length. The Pencoyd Iron Works, in "Steel in Construction," showed that the distance L in feet between bearings to care for a deflection of 0.01 inch per foot, due to the weight of the bare shaft alone, was given by the following:

$$L = \sqrt[3]{873 D^2}$$

For a working formula for bare shafts, with allowance made for the weakening effect of keyseats, we have:

$$L = \sqrt[3]{720 D^2}$$

where D = diameter of shaft in inches;

L = maximum distance between bearings in feet.

These results are said to be correct within the range of velocities usual in practice.

Prof. Rankine, in "Millwork," showed that the centrifugal

force of a shaft slightly bent was such that at short centers it restores itself to straightness; but that with a greater distance between centers, such a shaft is liable to keep rotating in its bent form. The same holds true for a shaft rotating at a high speed. Such a shaft at short centers will restore itself to straightness; but with a greater distance between centers, it will not have time to straighten out and will continue to rotate in a bent form. This condition is called the "centrifugal whirl," and in deducing a formula to determine the maximum distance between bearings, provision must be made to practically eliminate the centrifugal whirl. To deduce a fundamental formula to cover all the conditions and requirements met with in practice, is practically impossible, and reference must be made to a general formula. The following formulas take velocity into consideration as a precaution to reduce centrifugal whirling:

$$L = 5 \left(\frac{1500}{N + 1500} \right) D^{\frac{3}{2}} \quad (1)$$

$$L = 6.5 \left(\frac{1500}{N + 1500} \right) D^{\frac{3}{2}} \quad (2)$$

$$L = 9.5 \left(\frac{1500}{N + 1500} \right) D^{\frac{3}{2}} \quad (3)$$

where N = revolutions per minute.

Formula (1) is for head-shafts, or so-called "prime movers"; also, those shafts which are subjected to shocks and the bending action of pulleys, gears, etc., and which may be reversed under full load. Formula (2) is for the common type of lineshafts (except that part where the power is applied) and also for countershafts, with ample allowance for the bending action of pulleys, gears, etc., which are not reversed under full load. Formula (3) is for shafts and countershafts which are merely to transmit power without any bending action except that due to the weight of the bare shaft; and on such shafts all pulleys and gears are to be placed close to the bearings. The formulas hold good for

* For additional information on the strength of shafting and allied subjects, see also "The Angle of Torsion," by B. D. Pinkney, published in MACHINERY for November, 1914; "Heavy Duty Shafts with Two and Three Bearings," by W. G. Dunkley, April, 1914; "On Determining Shaft Diameters," by W. G. Dunkley, August, 1913; "Intermediate Supports for Long Shafts," by W. G. Dunkley, January, 1913; "Calculating Bending and Turning Moments for Long Shafts," by W. H. Herschel, July, 1911; "The Effect of Keyways on the Strength of Shafts," by H. F. Moore, January, 1911; and "Table for Computing Hollow and Solid Shafting," September, 1905.

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MAXIMUM DISTANCES BETWEEN BEARINGS FOR VARIOUS SIZED SHAFTS AND SPEEDS

Diam. of Shaft, Inches	Formula	Revolutions per Minute								Diam. of Shaft, Inches	Formula	Revolutions per Minute								Diam. of Shaft, Inches	Formula	Revolutions per Minute							
		100		200		300		400				100		200		300		400				100		200		300		400	
		Ft.	Ins.	Ft.	Ins.	Ft.	Ins.	Ft.	Ins.			Ft.	Ins.	Ft.	Ins.	Ft.	Ins.	Ft.	Ins.			Ft.	Ins.	Ft.	Ins.	Ft.	Ins.		
¾	(1)	4	3	4	0	3	9	3	7	1½	(1)	6	9	6	4	6	0	5	8	3¾	(1)	10	1	9	6	9	0	8	6
	(2)	5	7	5	3	4	11	4	8		(2)	8	10	8	4	7	10	7	5		(2)	13	2	12	5	11	8	11	1
	(3)	8	2	7	8	7	3	6	10		(3)	12	11	12	2	11	6	10	10		(3)	19	3	18	1	17	1	16	2
1	(1)	4	6	4	2	3	11	3	9	1¾	(1)	7	3	6	10	6	5	6	1	3½	(1)	10	8	10	0	9	5	8	11
	(2)	5	10	5	6	5	2	4	11		(2)	9	5	8	10	8	5	7	11		(2)	13	10	13	0	12	4	11	8
	(3)	8	6	8	0	7	7	7	2		(3)	13	10	13	0	12	3	11	7		(3)	20	3	19	1	18	0	17	1
1½	(1)	4	8	4	4	4	2	3	11	2	(1)	7	5	7	0	6	7	6	3	3¾	(1)	11	2	10	6	9	11	9	5
	(2)	6	1	5	8	5	5	5	1		(2)	9	8	9	1	8	7	8	1		(2)	14	6	13	8	12	11	12	3
	(3)	8	10	8	4	7	11	7	6		(3)	14	1	13	3	12	6	11	10		(3)	21	3	20	0	18	10	17	10
1¾	(1)	5	0	4	9	4	6	4	3	2¼	(1)	7	10	7	5	7	0	6	7	3½	(1)	11	8	11	0	10	4	9	10
	(2)	6	7	6	2	5	10	5	6		(2)	10	3	9	8	9	1	8	7		(2)	15	2	14	3	13	6	12	9
	(3)	9	7	9	0	8	6	8	1		(3)	15	0	14	1	13	4	12	7		(3)	22	2	20	10	19	8	18	8
1¾	(1)	5	3	4	11	4	8	4	5	2½	(1)	8	0	7	6	7	1	6	9	4	(1)	11	9	11	1	10	6	9	11
	(2)	6	10	6	5	6	0	5	9		(2)	10	5	9	10	9	3	8	9		(2)	15	4	14	5	13	8	12	11
	(3)	9	11	9	4	8	10	8	4		(3)	15	3	14	4	13	7	12	10		(3)	22	5	21	1	19	11	18	10
2	(1)	5	5	5	1	4	10	4	6	2¾	(1)	8	5	7	11	7	6	7	1	4¼	(1)	12	2	11	5	10	9	10	3
	(2)	7	0	6	8	6	3	5	11		(2)	11	0	10	4	9	9	9	3		(2)	15	10	14	10	14	0	13	4
	(3)	10	4	9	8	9	2	8	8		(3)	16	1	15	2	14	4	13	7		(3)	23	1	21	9	20	6	19	5
2¼	(1)	5	7	5	3	4	11	4	8	3	(1)	8	7	8	1	7	8	7	3	4½	(1)	12	7	11	11	11	3	10	8
	(2)	7	3	6	10	6	5	6	1		(2)	11	2	10	6	9	11	9	5		(2)	16	5	15	5	14	7	13	10
	(3)	10	8	10	0	9	6	9	0		(3)	16	4	15	5	14	7	13	9		(3)	24	0	22	7	21	4	20	3
2½	(1)	5	11	5	7	5	3	5	0	3½	(1)	8	9	8	3	7	9	7	4	5	(1)	12	9	12	0	11	4	19	9
	(2)	7	9	7	3	6	10	6	6		(2)	11	4	10	8	10	1	9	7		(2)	16	7	15	7	14	9	13	11
	(3)	11	4	10	8	10	1	9	6		(3)	16	8	15	8	14	9	14	0		(3)	24	3	22	10	21	6	20	5
2¾	(1)	6	1	5	9	5	5	5	2	3¾	(1)	9	0	8	6	8	0	7	7	5½	(1)	13	3	12	5	11	9	11	1
	(2)	8	0	7	6	7	1	6	8		(2)	11	9	11	1	10	5	9	11		(2)	17	2	16	2	15	3	14	6
	(3)	11	8	11	0	10	4	9	10		(3)	17	2	16	2	15	3	14	6		(3)	25	2	23	8	22	4	21	2
3	(1)	6	3	5	11	5	7	5	3	4	(1)	9	7	9	0	8	6	8	1	6	(1)	13	8	12	10	12	2	11	6
	(2)	8	2	7	8	7	3	6	10		(2)	12	6	11	9	11	1	10	6		(2)	17	9	16	9	15	10	15	0
	(3)	11	11	11	3	10	7	10	1		(3)	18	3	17	2	16	2	15	4		(3)	26	0	24	6	23	1	21	11
3½	(1)	6	7	6	3	5	10	5	7	4½	(1)	9	9	9	2	8	8	8	2	6½	(1)	13	9	12	11	11	11	11	11
	(2)	8	7	8	1	7	8	7	3		(2)	12	8	11	11	11	3	10	8		(2)	17	9	16	9	15	10	15	0
	(3)	12	7	11	10	11	2	10	7		(3)	18	6	17	5	16	5	15	7		(3)	26	9	24	11	21	11	21	11

Machinery

Machinery

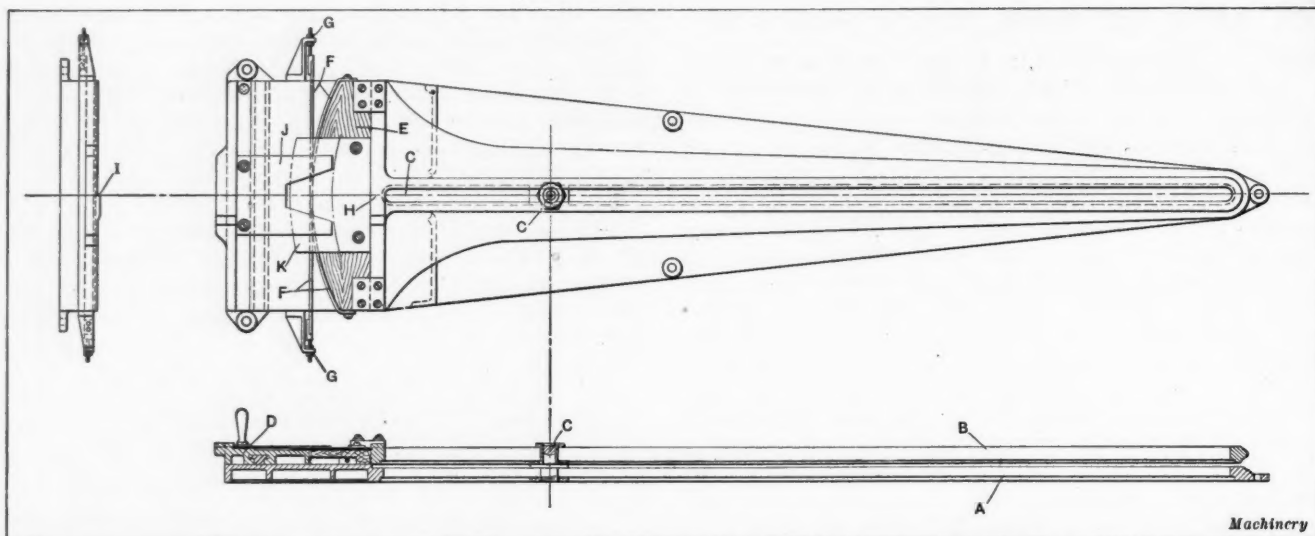


Fig. 1. Instrument for drawing Involute Curve Outlines for Gear-tooth Templets or Forming Tools, with Swinging Arm B in Central Position

either cold-rolled steel, turned steel, or wrought-iron shafts, the moduli of elasticity and torsional strength of these materials being nearly the same. The distance L for other materials varies directly as their moduli of elasticity, a complete table of which may be found on page 299 of MACHINERY'S HANDBOOK.

The writer experimented with shafts of different diameters at different velocities, for several years before deducing the preceding empirical formulas. Recently he connected a shaft 17/16 inch in diameter by 55 feet long to a variable speed transmission for experimental purposes, and tested for the conditions of Formulas (1), (2) and (3). For the conditions of Formula (1) at 100 revolutions per minute, a safe maximum distance of 6 feet between bearings was recorded, which had to be gradually reduced to 5 feet as the speed was raised to 400 revolutions per minute, the greatest deflection occurring during the reversal of the shaft at full load. When requirements were imposed to represent the conditions covered by Formula (2), a maximum distance between bearings of 7 feet 11 inches for 100 revolutions per minute, and 6 feet 5 inches for 400 revolutions per minute, was recorded. When tested for the conditions of Formula (3), a maximum distance between bearings of 11 feet 6 inches for 100 revolutions per minute, and 9 feet 6 inches for 400 revolutions per minute was recorded.

A number of tests have been made with shafts of larger and smaller diameters with like results, thus substantially corroborating the values obtained by Formulas (1), (2) and (3), all of which are for an elastic deflection of 0.01 inch per foot of shaft length between bearings. If the bearings are of

the rigid type, the distance between them is measured from end to end; but if the bearing is in any way self-aligning, the distance is measured between the centers. The accompanying table of maximum distances between bearings is calculated according to these empirical formulas.

* * *

INVOLUTE GEAR TOOTH FORMING DEVICE

SIMPLE METHOD OF LAYING OUT A TEMPLET OR FORMING CUTTER

BY GUS LUCK*

It is the purpose of this article to describe a method of generating the involute curves for a gear tooth templet or forming cutter by purely mechanical means so that the use of mathematics is unnecessary. The method of using the instrument employed for this purpose is quite simple. The piece of steel on which the templet or forming tool is to be laid out is secured to the end of a pivoted arm, the work being moved under a space formed to correspond with the interval between two rack teeth of the same pitch as the gear tooth for which the templet is required. The work is moved by short steps, and after each movement the outline of the rack space is scribed on it. Referring to Figs. 2 and 3, it will be evident that a great number of these outlines are drawn and their points of contact with the imaginary gear tooth lie on the required involute curve. Having the work laid out in this way, the templet is finished in the usual manner.

Figs. 1 and 2 show the mechanical device used for laying

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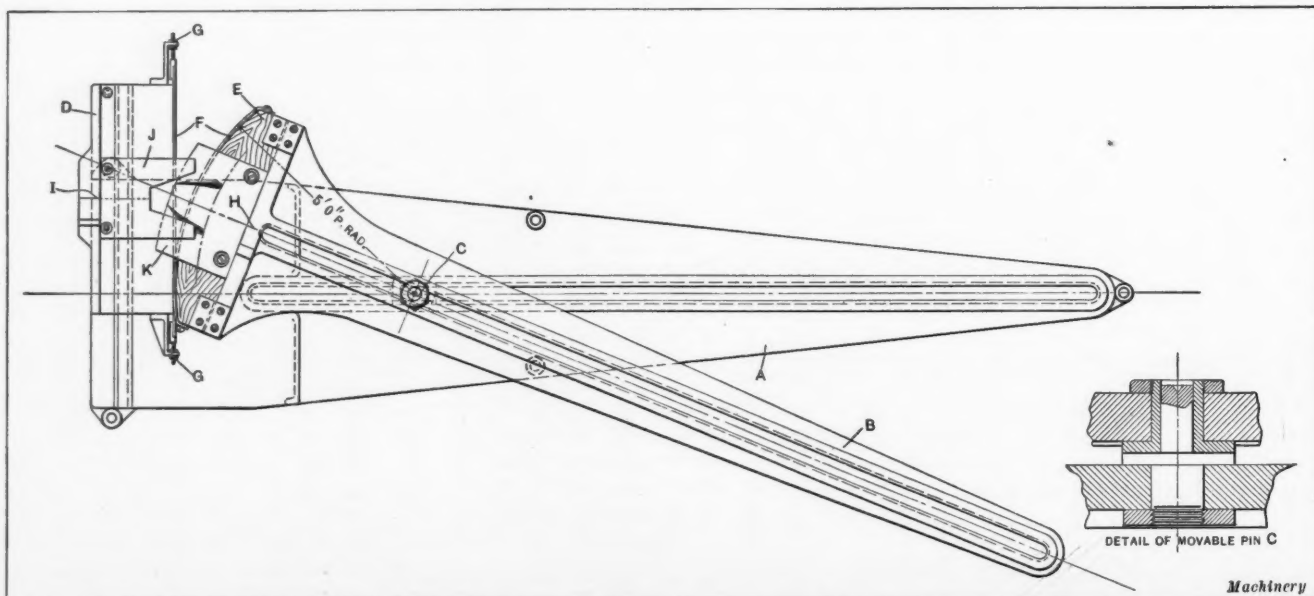


Fig. 2. Instrument shown in Fig. 1 with Arm B swung to Extreme Position—Detail of Adjustable Pivot Pin C

out a tool by this method. In Fig. 1 the arm is central, with the rack tooth templet and material for the gear tooth templet in place. In Fig. 2 the device has been moved over to one of its extreme positions, and this illustration shows the lines which have been scribed on the work. Fig. 3 shows various forms of rack templates and work laid out from them. In order to explain the use of this instrument, let us consider that it is required to generate a templet or forming tool for a gear of 10 feet pitch diameter with teeth of $\frac{1}{2}$ diametral pitch and $14\frac{1}{2}$ degree pressure angle, the teeth to be Brown & Sharpe standard with no clearance allowed. The templet shown at A in Fig. 3 would be used for this purpose. The first step is to take the material on which the templet or forming tool is to be laid out and scribe outside, pitch and root circles of the required radii on it. The work is then secured to the arm of the instrument ready to have the required tooth outline laid out on it.

Before going further with the description of the method of procedure, a description of the instrument will be given. The baseplate A supports the swinging arm B, and both the baseplate and arm have a slot machined in them in which a movable pin C is supported. The position of this pin may be varied in order to have the distance to the end of the arm equal to the required pitch radius of the gear for which the templet or forming tool is being made. When the pin C has been located in the required position it is secured against further movement. The cross-slide D at the end of the baseplate A is held and guided by means of the T-slot and tongue, which are clearly shown in the cross-sectional view, Fig. 1. Secured to the end of the swinging arm B there is a wooden block E, the outer surface of which conforms to a circle whose radius is equal to the pitch radius of the gear for which the templet is being made. It will be evident that a separate block E must be made for each gear of different pitch radius. It will be seen that a thin steel band F, the width of which is half the thickness of the wooden block E, is secured to each end of the block, and that the other ends of these bands are fastened to adjusting screws G at opposite ends of the cross-slide D. There is a center line H marked on the radial arm and a corresponding center line I on the cross-slide, and in setting up the instrument ready for use, these two lines are brought into alignment by means of the bands F and adjusting screws G, as shown in Fig. 1.

With the rack templet J and the blank K for the gear-tooth templet secured in the relative positions shown in Fig. 1, the cross-slide is moved over a little way at a time. When this is done, the steel

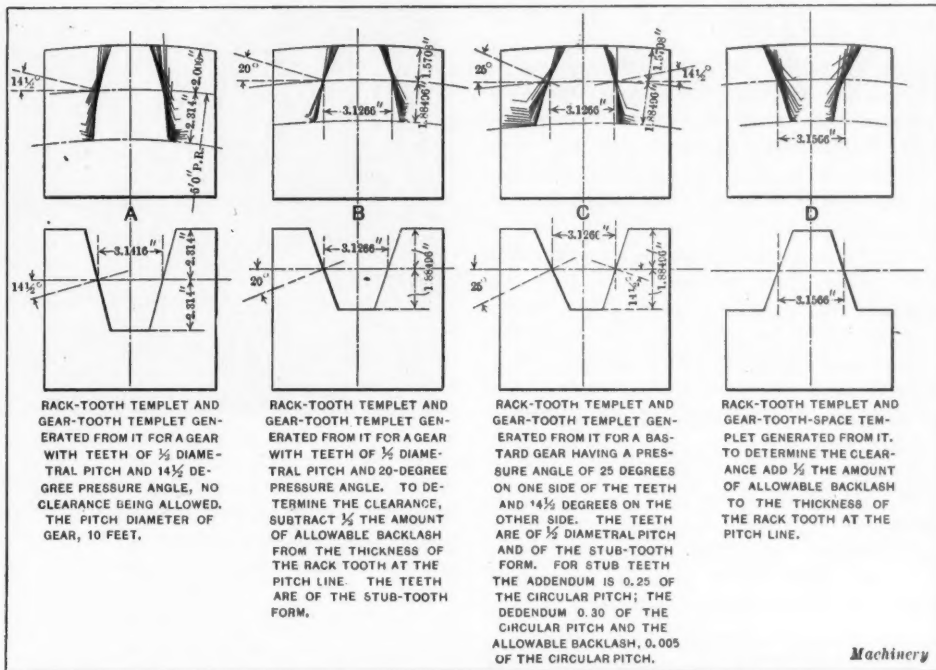


Fig. 3. Rack Templates of Various Forms and Gear-tooth Outlines generated from them

out must be secured on a wooden block in a radially accurate position; and with the cross-slide in its central position, the center of the rack templet on the slide and the blank mounted on the swinging arm must be in perfect alignment. It may be claimed that the cost of this instrument would not be justified unless there was a great deal of work to be done on it. Where only a small amount of work is to be done, an instrument of the form shown in Fig. 4, which is made entirely of wood, will be found to give satisfactory results. The cost is relatively small.

The Bureau of Labor Statistics of the United States Department of Labor has published as Bulletin 163 a report on wages and hours of labor in the building and repairing of steam railroad cars. The report is based on information obtained from the principal representative establishments in the industry. Figures are presented in this bulletin for rates of wages per hour and full-time hours of labor per week for the years 1907 to 1913 and for full-time weekly earnings for 1910 to 1913. Full-time weekly earnings of the employees in the principal occupations in this industry in 1913 were 5.5 per cent higher than in 1912, 6 per cent higher than in 1911, and 8.9 per cent higher than in 1910; average rates of wages per hour for 1913 were 6.3 per cent higher than in 1912, 6.4 per cent higher than in 1911, and 9.9 per cent higher than in 1910; the full-time working hours per week in 1913 were 0.7 per cent lower than in 1912, 0.4 per cent lower than in 1911, and 1.1 per cent lower than in 1910. The data for 1913 were obtained from 73 representative establishments and covered over 42,000 employees. The average full-time weekly earnings in 1913 in the principal occupations in these representative establishments were as follows: cabinetmakers, \$19.03; carpenters and car builders, \$17.11; car repairers, \$15.15; fitters, \$15.99; laborers, \$10.58; machine woodworkers, \$16.26; machinists, \$17.81; painters, \$17.77; pipe fitters, \$18.56; riveters and buckers, \$19.41; tanners, \$19.28; truck builders, \$15.31; upholsterers, \$19.50. In 1913 the full-time hours of labor per week were under 54 in quite a number of the establishments visited and over 60 in but very few. The average full-time hours per week were about 56.

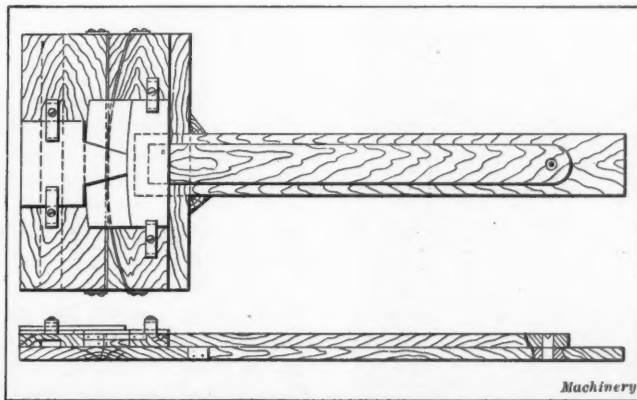


Fig. 4. A Simple form of Involute Curve Drawing Instrument made entirely of Wood

FITTING CROWN BRASSES ON A DRAW-CUT SHAPER

A familiar machining operation in the railroad shop is the fitting of crown brasses to driving boxes. A typical driving box brass is shown in Fig. 1, and the fitting consists in machining the outside semicircular section and the side edges, so that it will just drive into its place in the box. There are several common ways of doing this fitting, one of which is to mount the semicircular brass casting on an arbor and turn off the outside. This method requires an additional setting to machine the edges. Another way is to hold the casting on the circular table of a slotting machine and rotate the work while slotting, finishing the edges by slotting at the same setting. The illustrations show another method of machining crown brasses, using a Morton draw-cut shaper that has worked out satisfactorily at the shops of the Delaware & Hudson R. R., Watervliet, N. Y.

Referring to Fig. 2, which shows the operation as a whole, and Fig. 3, which shows the details of the job, it will be seen that the crown brass is held by a special mandrel chuck that grips the work by the ends. This chuck is mounted on a circular attachment on the table of the shaper. The crown brass casting is laid out for machining in the usual way, and

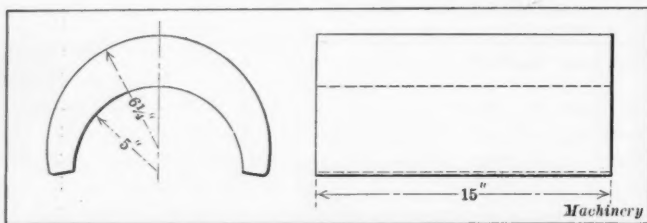


Fig. 1. Driving Box Crown Brass

after lightly pinching it in the chuck, it is lined up with an indicator that swings on the central shaft of the fixture. After tightening the clamping bolts of the mandrel chuck, the roughing cut is started.

Between each shaper stroke, the work is turned slightly by a simple worm and worm-wheel, operated from the cross-feed shaft of the shaper. The work is thus turned while the cutting is going on, and two cuts—one roughing and one finishing—are sufficient to finish the circular portion of the crown brass. One of the edges is next shaped off radially with the

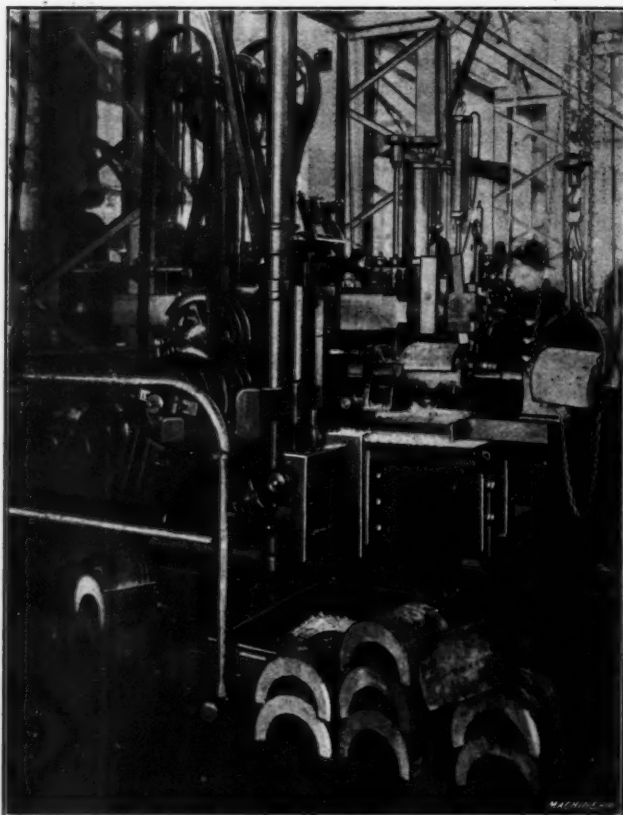


Fig. 2. Morton Draw-cut Shaper used on Crown Brass Fitting

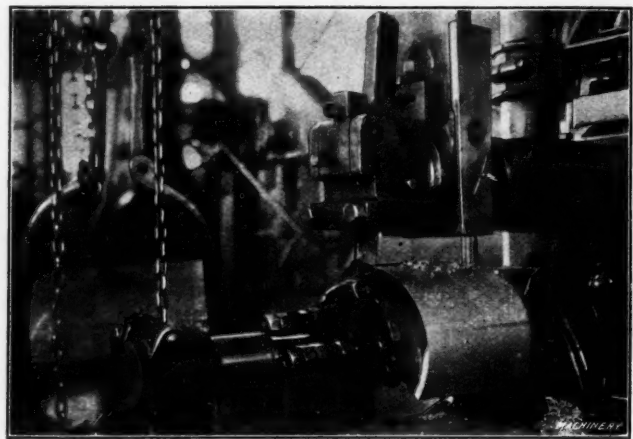


Fig. 3. Close-range View of Operation

work, and by means of the circular gage the distance for the opposite end is marked. This is then finished at the same setting and the crown brass is ready to be put into its seat in the driving box. An apprentice can operate this machine and finish a crown brass complete, ready for fitting in its driving box, in twenty minutes.

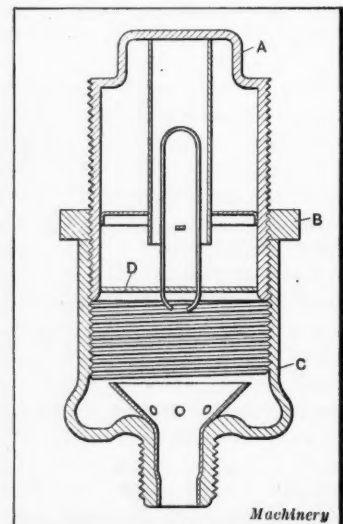
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* * *

COMPRESSED AIR GREASE CUPS

The accompanying illustration shows a grease cup described in *Engineering*, the feed of which, instead of being effected by a spring in the usual manner, is worked by compressed air. These cups are made by Lubricators, Ltd., Leeds Place, Tollington Park, London. With spring-worked feeds, it is desirable to have a number of springs of varying capacity to provide a pressure suitable for different qualities of grease; or the grease cup may be provided with a strong spring and the feed may be regulated by an arrangement fitted in the body or neck of the cup for throttling the feed. This method, however, often leads to the clogging of the feed altogether. In the case of the compressed air cup, springs are unnecessary and there is no need of throttling, as the feed depends entirely upon the amount the top of the lubricator is screwed down, and the full bore of the outlet is always used. Another advantage claimed for the compressed air cup is that if the bearings should heat, the air in the grease cup would also be warmed and expanded, thus increasing the pressure and also the supply of lubricant delivered to the journal.

The lubricator, as will be seen from the illustration, consists of three main parts: a cup *C*, a cover or top *A*, and a lock-nut *B*. Parts *A* and *C* are pressed out of mild steel or brass. The top *A* contains a suspended disk *D*, the object of which is to keep the upper surface of the grease flat, and prevent the air from forcing a passage through the grease. When the cup is filled with grease, this should be packed down so as to prevent large air cavities in it. The suspended disk is pulled out to the end of top *A*, and the latter is screwed into the cup about $\frac{1}{4}$ or $\frac{3}{8}$ inch, this being sufficient to compress the air the required amount, as all parts are hermetically sealed by the grease. The lock-nut is then tightened by hand. The small funnel at the bottom of the cup is made of thin sheet steel so that if the bearing becomes heated, the heat is quickly transferred to the grease, which melts and runs down.

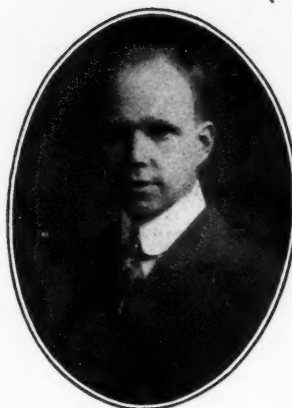


A Grease Cup where Flow of Lubricant is regulated by Air compressed within it

THE MANUFACTURE OF CHAIN*—1

PRINCIPLES AND MACHINES EMPLOYED IN MAKING CHAINS OF VARIOUS TYPES

BY FRANK H. MAYO†



Frank H. Mayo†

CHAINS are made in many forms, and with the exception of a few types of fancy chains used for jewelry and similar purposes, the links are flexibly connected with each other. The size of a chain is usually specified by the thickness of its links; for example, a $\frac{3}{8}$ -inch chain is one made from bar metal $\frac{3}{8}$ inch in diameter. The metal used in the manufacture of chain must be very malleable and ductile to allow the bar or wire to be bent and twisted into the desired form of links. Chains are used for a variety of purposes, and their names are often derived from the purpose for which they are to be used, as anchor chain, surveyor's chain, etc.; or the name may be derived from the material from which the chain is made, as steel, iron, gold or silver chain. But the most common method

* For other articles on chain making and allied subjects published in MACHINERY, see "Chain Making by the Ton," October, 1911; "Making Diamond Auto Truck Chain," May, 1911; "Making Heavy Chain and Anchors for Uncle Sam," February, 1910; "Chain Making Extraordinary in a Scrapless Press Room," November, 1909; and "A New Process of Making Weldless Chains," July, 1907. For articles on wire forming, see also "Spring Winding and Colling," October, 1914; "Fixtures and Machines for Wire Forming," September, 1914; and other articles there referred to.

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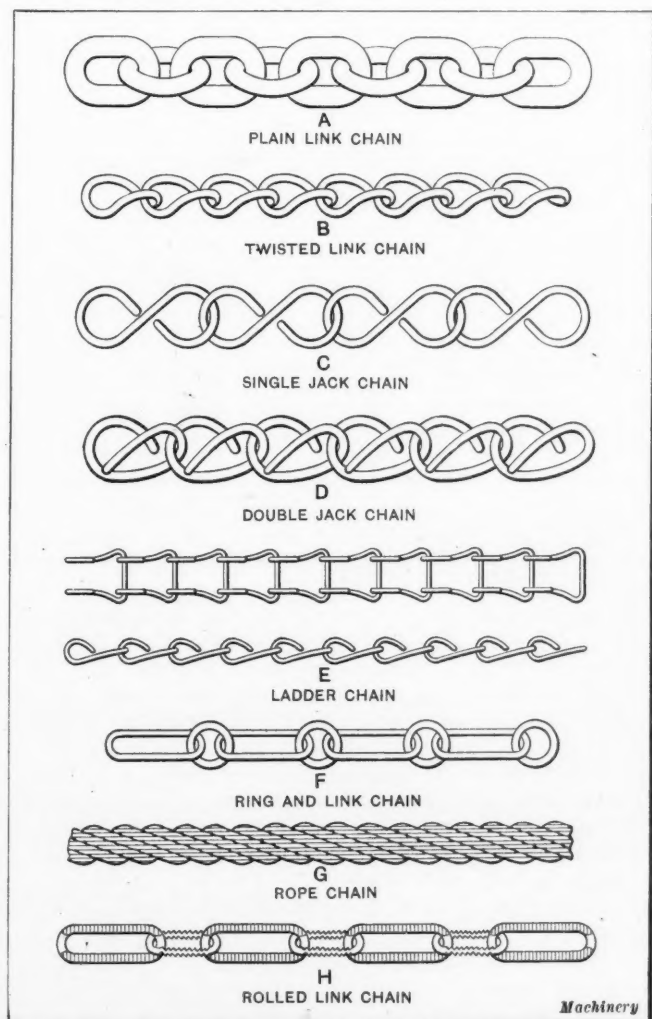


Fig. 1. A Few Typical Examples of the Different Types of Chain

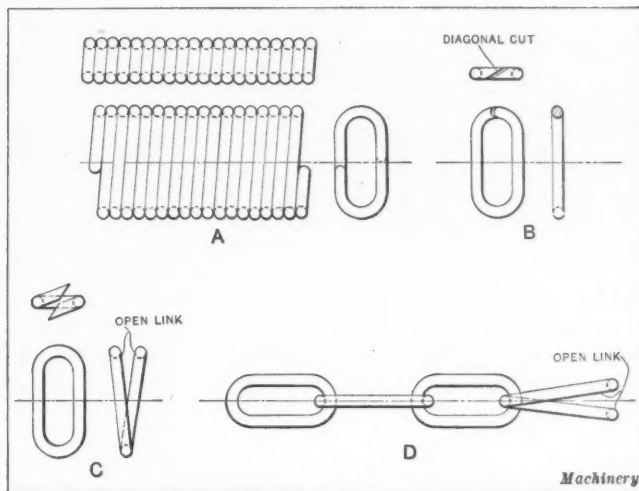


Fig. 2. Operations involved in making Plain Link Chain on the Coiling Machine and by Hand

of nomenclature is based on the shape of the links; and this has resulted in the development of such terms as ladder chain, rope chain, twisted link chain, flat link chain, etc. Possibly the most complete method of naming is a combination of the two latter systems, specifying the shape of the link and the material from which the chain is made. In this way a more complete description is afforded.

It is the purpose of this article to describe some of the methods and machines used in chain manufacture, and in order to enable those who are not familiar with the principles employed in this industry to obtain a general working knowledge of the subject, some of the simpler principles are included. One very important point in chain making, as in all wire forming operations, is to have the wire free from kinks which would show in the finished product. Various forms of wire straighteners are employed for this purpose. In one common form there is a series of rolls that may be arranged in various ways according to the nature of the work. The wire is passed between these rolls as it is fed into the machine, and as a result all kinks are removed. The general practice is to draw the wire through the straightener, although in certain cases the straightener is drawn back and forth along the wire. In another form of wire straightener quite generally used, the wire is simply drawn between staggered pins to straighten out the kinks.

Fig. 1 illustrates some common types of chain; a plain link chain is shown at A, a twisted link chain at B, a single jack chain at C, a double jack chain at D, a ladder chain at E, a ring and link chain at F, a rope chain at G and a rolled link chain at H. In this connection it may be mentioned that the rolled link chain is a chain which has been passed through a set of rolls to flatten out the links. In addition to these common types of chain, other examples will be referred to in the later sections of this article.

A type of coiling machine often used in making chain from medium and heavy sizes of wire is shown in Fig. 3. This cannot be classed as a complete chain making machine because it does not make the links entirely but merely coils the wire into a spiral which is then cut up into individual rings from which the links are made. The successive operations in the manufacture of chain by this process are shown in Fig. 2, the coil of wire, as produced on the machine illustrated in Fig. 3, being shown at A. An individual link cut from this coil is shown at B, where it will be seen that the cut is made diagonally to provide for making a scarf weld, if so desired. The link is shown at C sprung open to enable it to be interlocked with the previous link of the chain. These individual links are then assembled to form the complete chain as shown at D. After the links are "sprung" together, the joints must be welded or brazed. In operating the coiling machine shown

in Fig. 3, the wire passes through the straightening rolls *A* to the arbor *B* which is of the same shape and size as the links that it is desired to produce. The wire is clamped to the arbor and kept in close contact with it by means of guide rolls which are held by weights attached to the ends of suitable levers as shown at *D* and *E*. This is a simple method and one which produces very good links for hand welding.

When it is necessary to make up various types of fancy chain and the demand for any one style is relatively small, it would not be practical to set up an elaborate machine. This is particularly true in cases where the links in a single chain are of various forms, i.e., one long and one short, or where various fancy forms of links are used in the chain at specified intervals. In such cases a combination hand and machine method can be used to very good advantage, the set-up of the machine being shown in Fig. 4. Reference to this illustration will show that the method is nothing more nor less than the common method of spring winding on the lathe, adapted to the requirements of the chain making industry.

blanks are first stamped out from sheet metal in the form of washers, or holes are punched in round disks as shown at *A*. The ring produced in this way is next subjected to a swaging operation or some similar process by which it is brought to a round section, as shown at *B*. The next step consists of drawing out the links to an oblong form as shown at *C*, after which each link is bent double, bringing it to the condition shown at *D*. The finished chain *E* is then assembled by threading the individual links together. This makes a neat chain of uniform strength, the danger of weak links due to defective welds being avoided.

As in all industries of long standing, the original methods of chain making were quite primitive and some of these old methods are still employed in making certain classes of chain; but at the present time most of the chain is produced on automatic machines designed especially for the production of a certain class of chain. This is naturally the case, as the manufacture of small fancy chains is conducted along quite different lines from those followed in the making of com-

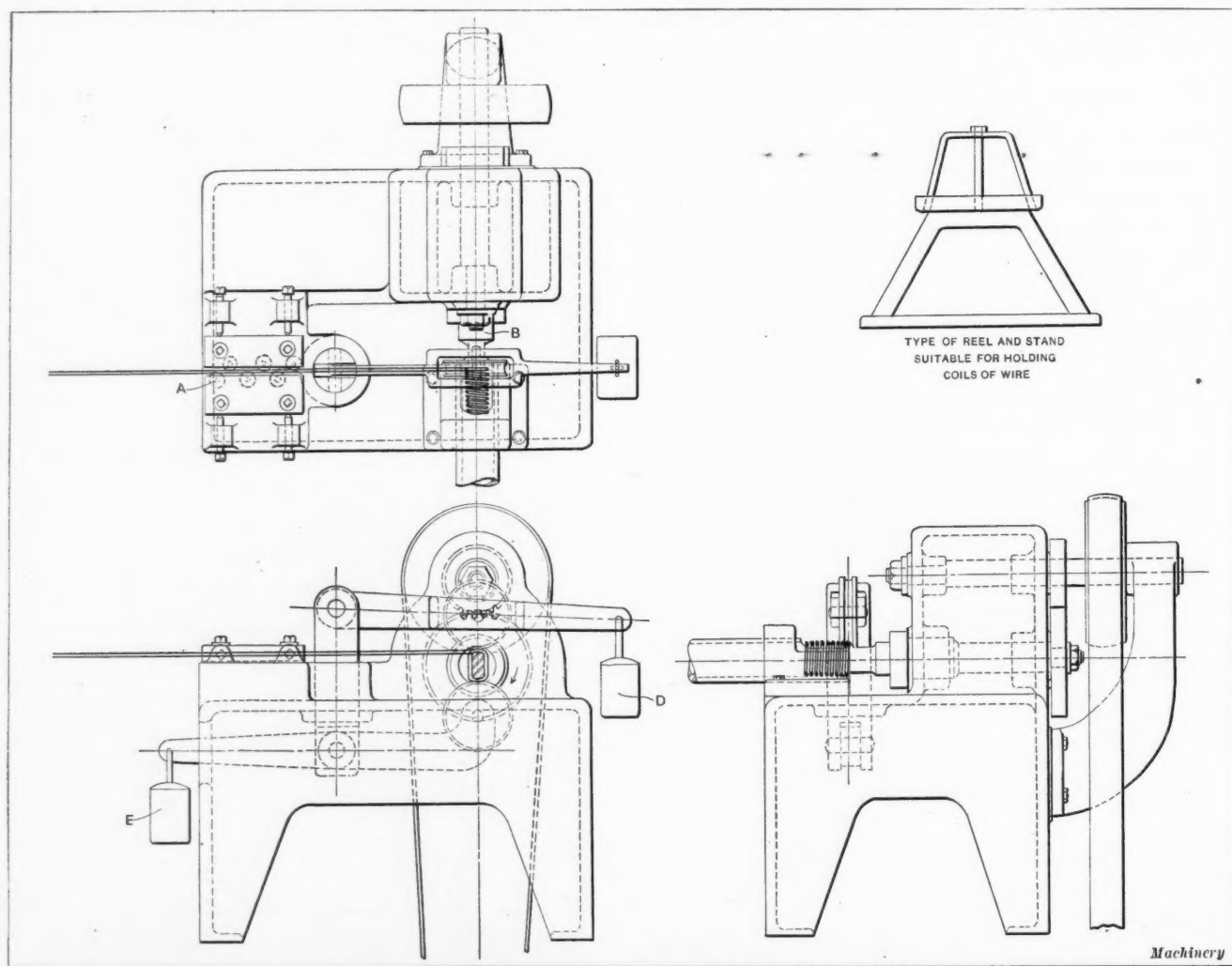


Fig. 3. General Construction of Machine for rolling Wire into Spiral Coils

The arbor *A* on which the wire is wound is made to correspond with the form of link that is to be produced. After the wire has been wound on the arbor, the coil is cut up into links by means of a fine-toothed saw, the arbor being provided with a groove in which the saw runs. In most cases links of this type are cut apart without attempting to make the diagonal or "scarf" cut, as such links are generally soldered or brazed together. Fig. 5 shows an end view of the arbor on which the wire is wound, and the saw in position to perform the cutting operation.

While by far the most common method used in the manufacture of chain is that which necessitates the cutting off of the wire and subsequent joining of the links by welding or some other means, some of the strongest chains are made by the production of the so-called "weldless" links. One style of chain produced in this way is illustrated in Fig. 6 where the principle of manufacture is clearly illustrated. The

commercial types of jack and ladder chains. Likewise, the machines employed in the production of large welded-link chains require welding apparatus to be incorporated in their design. In order that the movements involved in an automatic chain making machine may be thoroughly understood, the reader is referred to Fig. 7, which illustrates the form of machine employed in making plain link chain. This illustration shows the method of manufacture employed, and the individual steps are shown in detail in Fig. 8. Reference to the latter illustration will show that the wire is first cut off to the required length as shown at *A*; it is next bent around an arbor as shown at *B*; the ends of the link are then turned in as shown at *C*, where it will be seen that the link is practically closed; the finished link is shown at *D*; and the link is held as shown at *E* to have the wire for the next link threaded through it. The cycle of operations may be repeated indefinitely to produce chain of any required length.

In starting to make chain on the machine shown in Fig. 7, the wire, which is coiled on a reel mounted on a suitable stand, is fed through the straightening rolls and then passed into the feed slide A, from which it is carried on through the guide B until it engages the stop C. When the wire engages the stop, the feed slide remains stationary, while the jaws D are advanced by the action of cams E until they hold the wire against the arbor F to prevent the blank from dropping out of place when it is cut off. The cutting off of the blank is effected by the blade G which is operated by cam H, the motion being transmitted through the rocker arm J in the direction shown by the arrow. After the blade G has been returned to its original position by means of a spring, the jaws D are advanced by another rise on the cams E, thus causing the wire to be bent around the arbor F to partially form the link. The second step in the forming operation is obtained by closing the jaws D around the arbor F, this movement being effected by the side cams K which swing the jaws around the stud L on which they are carried, thus bending the

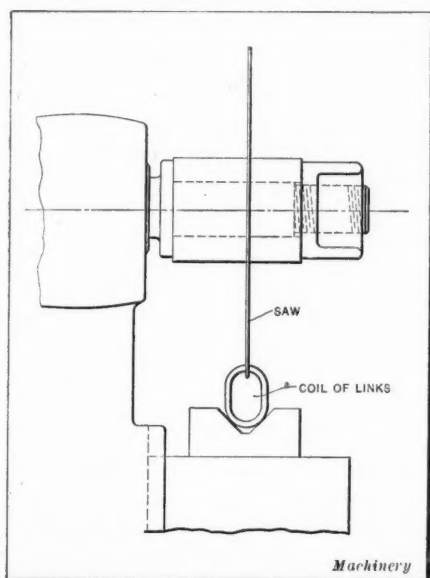


Fig. 5. Method of sawing apart the links after coiling

link completely around the arbor. The arbor is next moved slightly in order to loosen the link on it, and the ends of the link are then turned in through the action of the swage M which is operated in the same manner as the cut-off blade G, the motion being effected by the cam N and transmitted to the swage through the rocker arm P.

While this cycle of operations is being performed, the feed slide A is drawn back against the stop screw O which is located at the end of the wire straightener. The position of the screw O may be adjusted to control the distance that the feed slide moves back, and in this way the length of the blank cut from the wire can be regulated. That this is the case will be readily understood when it is remembered that the cam which operates the feed slide always moves the slide forward to the same position. Owing to the fact that the feed

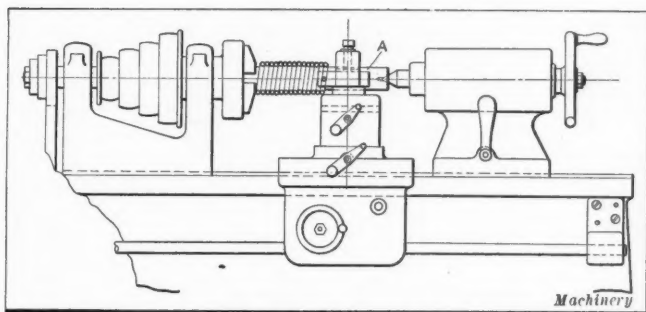


Fig. 4. Winding a Coil of Chain Link Blanks in the Lathe

slide must release its grip on the wire before returning, and that when its grip is released there is a tendency for the wire on the reel to slip back, some means must be provided to prevent such a movement of the wire. This is done by means of the pin R which is caused to grip the wire at the right moment by means of the cam S and rocker arm T which force the

pin R firmly against the wire and hold it in a fixed position until the feed slide has secured a fresh hold.

After completing the cycle of operations on a given link, means must be provided for making the connection between this link and the successive link of the chain. This is done by picking up the link from the arbor at the proper moment.

For this purpose the cam U lifts the rocker arm V and causes the hook W to descend and catch under the link at the moment that the arbor F drops down. This leaves the link suspended on the hook W where it is in the proper position for the wire from which the next link is to be formed to be passed through it. After this has been done, the hook releases the link which is left suspended on the wire, after which the required cycle of operations is gone

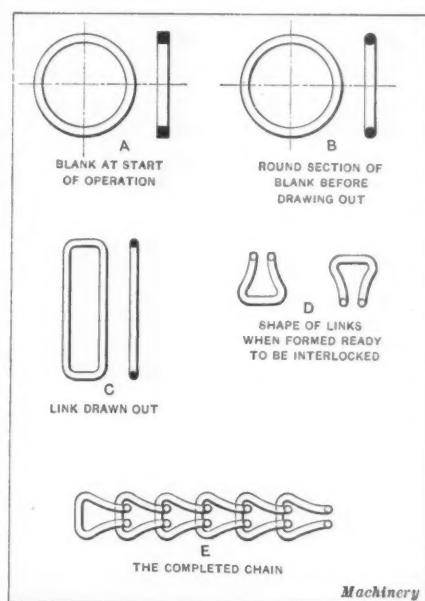


Fig. 6. Operations involved in the Manufacture of Weldless Chain

through to form the next link. This process is repeated over and over until the required length of chain has been produced. The finished chain passes through a hole in the machine and is received in a container which revolves in such a way as to prevent the chain from becoming tangled.

Referring to the bottom of Fig. 8, in which the chain is

shown in the condition which it has reached after each successive operation, the process of manufacture may be briefly summed up as follows: First, the wire is fed through to the stop and the blank F is cut off; second, the jaws come forward and hold the wire blank in position against the arbor, and the jaws bend the wire around the arbor to the form shown at G; third, the jaws are closed in to complete the forming of the link, the arbor moves slightly to loosen the

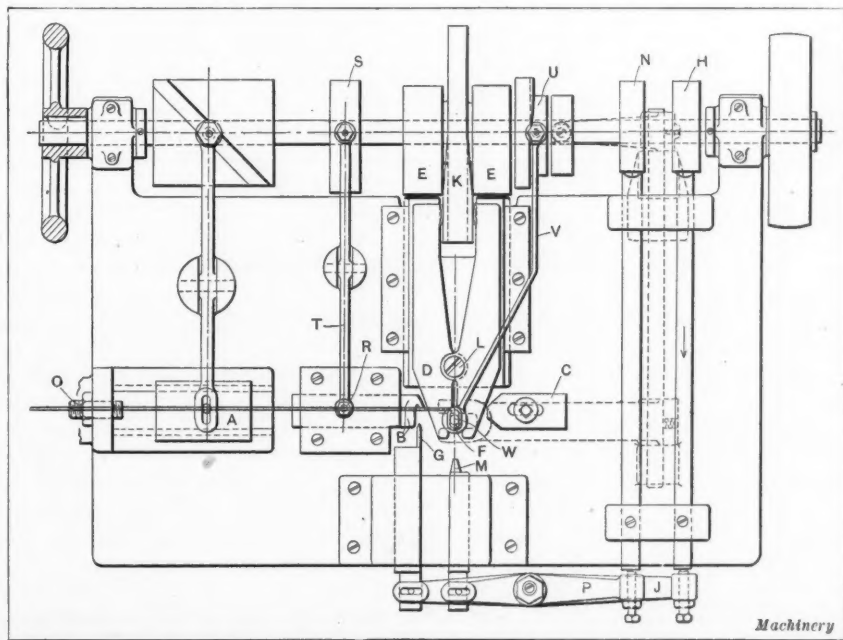


Fig. 7. General Arrangement of an Automatic Chain Making Machine

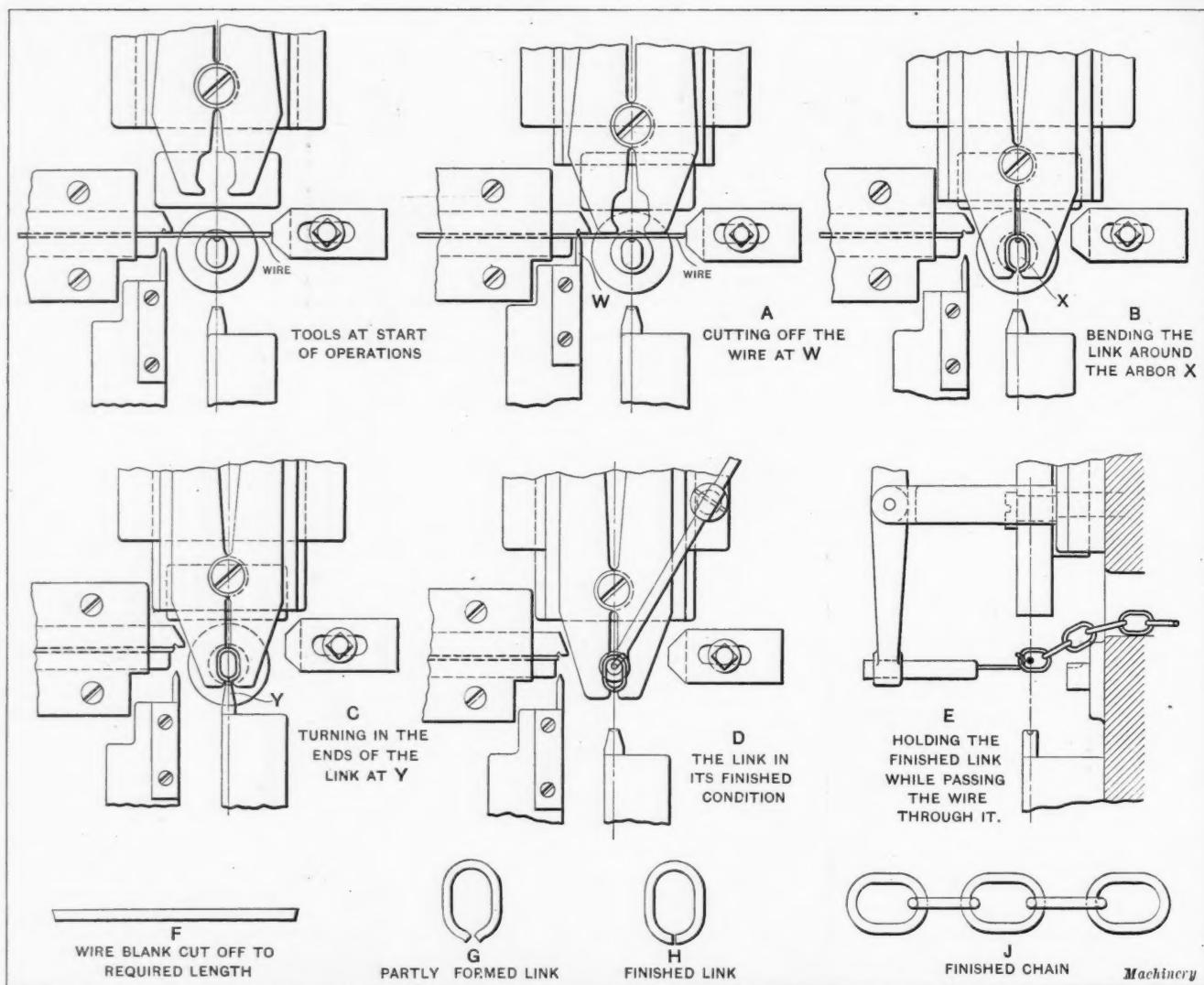


Fig. 8. Successive Operations performed on Machine shown in Fig. 7

link on it, the ends of the link are turned in as shown at H, and at the same time the binding pin secures its grip on the wire as the feed slide moves back to take a new grip; fourth, the arbor drops out of the link which is picked up by the hook and suspended on it, and the wire for the next link is fed through the finished link as shown at J, after which the cycle of operations is repeated. This method is best adapted for links $\frac{3}{16}$ inch in length or larger, as the hook is likely to miss when it is required to pick out the links of very small chains. However, machines of this type are fitted with a stop motion which disengages the clutch in the event of the chain falling out of the machine through the failure of the hook to suspend the last link ready for its engagement by the following blank. This machine may also be used for making plain rings or individual links, for which purpose it is merely necessary to disengage the hook which picks the finished link off the arbor.

In most cases the fancy types of chain for decorative pur-

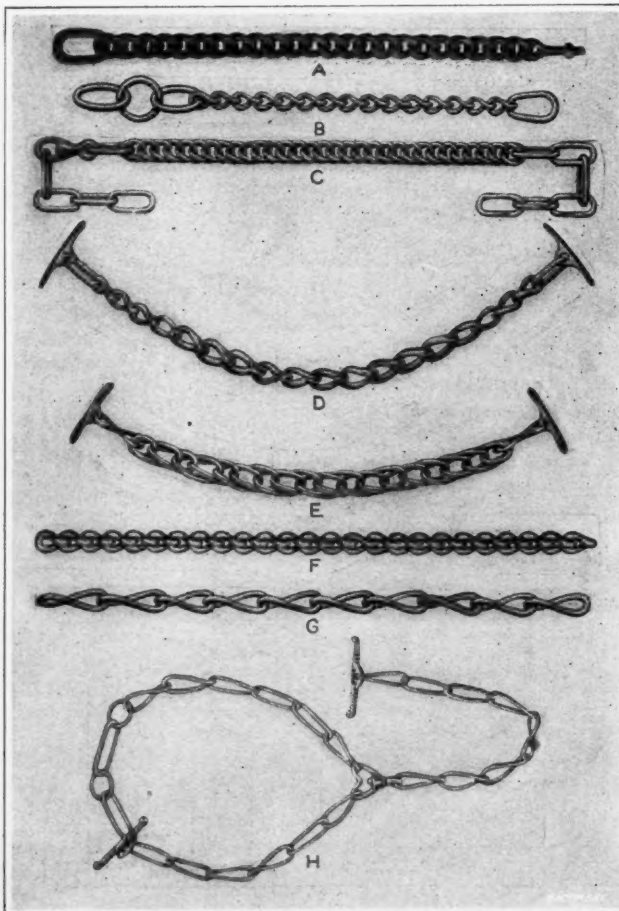


Fig. 9. Various Patterns of Twisted Link Chain

poses have the links soldered or brazed together, making a seamless appearance. After this has been done the links are cleaned and tested in order to discover any weak links that may exist through defective joints. Commercial types of chain, where a good appearance is not necessary, and which are not required to do heavy work, are left with the ends of the links open, while cable chains have the links welded at the joints. Fig. 9 shows a collection of different forms of twisted link chains. Chains in which the links are twisted were originally made by holding one end of the link and twisting it at the opposite end with a pair of pliers. After this had been done the link was flattened by tapping it with a small mallet or by passing it through a pair of rolls. It is only natural to assume that modern methods of manufacture have largely done away with this crude method of making twisted chain; and as a matter of fact, it is now produced by automatic machinery. Referring to the variety of patterns of twisted chain shown in

Fig. 9, A is a short twisted chain which may be wrapped snugly around a bar. A wagon-back chain is illustrated at B which has closely twisted links, in which the twist is a full quarter turn. A double cart-back chain is shown at C, while the chain illustrated at D is a type of single-tapered breast chain, and reference to this illustration will show that the links vary in size, growing smaller from the center toward one end. A double breast chain is shown at E, and F illustrates an example of a chain with very closely twisted links. The two remaining examples G and H are shown for the purpose of illustrating more open patterns of twisted chain.

* * *

THE SPACING OF MACHINES*

Many manufacturers handicap themselves by crowding the machines in their factories together and limiting the aisle spaces, in the belief that greater economy and production will be gained thereby. There is certainly no advantage, however, from a production standpoint, in placing machines so close that the workmen interfere with one another. If the workmen are paid by the day they are likely to stand idle while the operation of a near-by machine interferes with their work; and where the piecework system prevails, each employe, knowing that his wage will depend upon his production, is likely to continue his work in spite of difficulties and dangers to which he may be subjected. His movements are likely to interfere with his neighbors' work, just as their movements interfere with his own; and where the crowding is excessive the likelihood of accident is often very great. Serious results frequently follow from trifling causes, and a slight push may cause a workman to lose his balance, so that in recovering himself he may thrust his hand, arm, or foot into some moving part of the machinery, and be badly injured. To afford adequate protection to the workman, the machines should always be properly separated from one another, and they should also be set at safe distances from walls and posts and other fixed parts of the building.

Inadequate spacing is especially dangerous in connection with machines that turn out work of considerable length, or into which long pieces of raw material are fed. The operator of each machine must necessarily confine his attention closely to his own work, and so may be struck unexpectedly, and injured, by a bar or other object projecting from a machine near by. Under some circumstances one end of a bar of this kind may be caught in an unprotected gear or other moving part of the next machine, and suddenly transformed into an erratic, revolving flail, or twisted or broken into flying pieces. In either case the chance for injury to the employes in the immediate neighborhood is great.

The following conditions were observed during a recent inspection of a shop in which coal-mining drills are manufactured. On the same floor certain machines are used to sharpen one end of the drills, and others are used to square up the opposite end, to fit the crank. Most of the drills are not over three feet long, and the machines are spaced so that work on drills of this length can be carried on upon all the machines at once, without interference. Sometimes, however, drills from four to six feet long are made by the same machines, and operators are then obliged to work in a space which, although ample for making three-foot drills, becomes dangerously crowded when six-foot drills are substituted. The operator, intent on the work at one end of the drill, is likely to overlook the fact that the other end is dangerously close to his neighbor and his neighbor's machine, on the right, while the drill of the workmen on the left bears the same relation to him. Under these conditions there is an ever-present danger of cutting or otherwise injuring a fellow-worker at the next machine, or one walking along the aisle. The principle here noted in connection with work of one special kind applies also to many other industries, and should not be forgotten.

It is seldom that machines are crowded together when wide aisles are provided. Limited machine-space and limited aisle-space usually go together, and in such cases there is rarely sufficient space, near the operators, for the safe storage of material or finished product. Furthermore, the operators

usually take little care to arrange the pieces in orderly fashion, but simply let the material lie wherever it falls. There is seldom room for trucks, or for a sufficient number of trucks to serve all the machines. One of two dangerous conditions will then prevail: either there will be excessive heaping or piling of material in the already crowded space, or there will be a constant procession of workers bringing in raw material and removing finished product.

When piles of small castings or of other finished or unfinished material lie on the floor of a shop, some few of the pieces almost invariably become separated from the others, and persons passing by often stumble over them. A simple fall upon the floor may cause a bad injury, and the likelihood of a serious result is greatly increased when a man who has tripped over one of these objects falls in the direction of a moving machine. This may happen at any moment in a shop where the machines are closely spaced, and where limited aisle-space is provided and piles of working material are allowed to remain on the floor. Any workman in going from one machine to another under such conditions must be extra vigilant to avoid colliding with other men or with materials they may be handling, and he must also be careful to avoid tripping over tools or material lying on the floor.

The men or boys who supply the machine operators with raw material, or remove the finished or partly finished product, are in danger of injury to themselves or of causing injury to others, in several ways. The truck will take up a large portion of the already limited space, and any person who wishes to use the passage is at a disadvantage. The man loading the truck is likely to have his hand or clothing caught in neighboring machinery, or he may accidentally move a belt-shifting rod or other machine-starting device. Any one of these actions is likely to cause an accident.

In pushing trucks about the shop it is often necessary for them to pass one another, and there is seldom any special place or space reserved for this purpose. The men in charge of the trucks usually take advantage of the first handy nook or recess, and try to get by one another. In doing this their hands often become bruised, lacerated, or crushed. If the men try to pass in the narrow aisle the trucks are likely to collide, thus knocking off some casting or other object that may have been insecurely placed. In the event of an injury of this kind, the crowded condition of the shop is not held accountable for it, as a rule—some other proximate cause being assigned. This is in accordance with the general principle that a *thing* or a *person* often bears blame that should rightfully be placed upon a *condition*.

The manufacturer who is seeking safety and efficiency will ascertain, beforehand, the dimensions of the machine he is to install, and he will also find out how much space should be allowed for the worker, and how much area his operations will cover. He will likewise ascertain the probable rate of production, and the rate at which the material can be supplied and the product passed on to other departments. With this information at hand it is easy to lay out the factory and locate the machines, so that efficiency, orderliness, and safety will all be assured. It is an excellent plan to have so-called "dead-lines" painted conspicuously on the floor to mark the limits of the aisles. Lines of this kind should be re-painted whenever they tend to become indistinct, and foremen should see that nothing is allowed to extend over them.

* * *

An interesting statement is made by a French publication to the effect that the number of deaths of aviators in the war service is very much smaller than the death records in time of peace, one of the explanations being that aerial navigation is quite safe when there is no indulgence in exhibition stunts that have brought so many disasters. When an aeroplane is handled by a skillful aviator for the legitimate purpose of plain flying, it is a very much safer means of transportation than is generally believed. Another matter of considerable interest is also mentioned in connection with aviation in Russia. That country has within the last two years trained a very large number of men in aviation, and as a result has more skilled aviators in its military service than any of the other warring nations.

* Abstracted from "The Travelers Standard."

EMPIRICAL WORM-GEAR FORMULAS*

RUNNING PROPERTIES OF WORM-GEARS IMMERSED IN OIL

BY E. S. HEDSTROM†

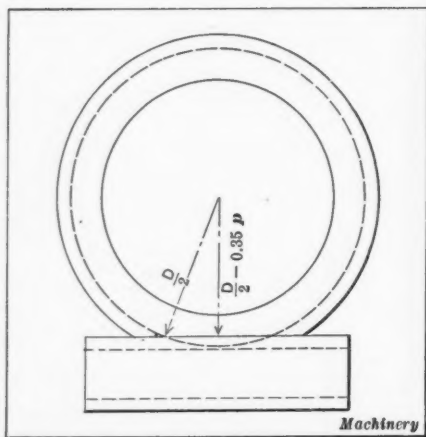


Fig. 1. Diagram showing Method of deriving Formula (2)

A GREAT deal of information has appeared in the technical press and elsewhere concerning the running properties of worm-gears, but very little has been published concerning their limit loads. This is largely due to the fact that so much depends upon the conditions under which the gears run and the quality of oil with which they are lubricated. To try to develop a strictly theoretical formula for the limit pressure on the teeth of worm-gears and in that way to obtain the safe working load, does not appear to be practical. A more feasible plan seems to be to derive a formula covering the main points which must be taken into consideration, and then apply a constant in connection with the formula, which has been determined by experiment. The cause of failure of a worm-gear may be due either to the fact that it lacks mechanical strength or to the breaking down of the oil film between the teeth of the worm and worm-wheel. The calculation of the strength of the teeth is made in the usual way; i.e., a tooth is regarded as a cantilever on which the load is applied at a point near the center of the tooth at the pitch line.

Let l = length of worm thread per revolution;

β = angle of worm subtended by wheel = 70 degrees;

W = actual width of tooth = $l \times \frac{\beta}{360}$;

p = circular pitch;

T = thickness of tooth = $\frac{p}{2}$;

S = tensile strength of metal.

The length of the cantilever is approximately equal to the dedendum of the tooth = $0.3683p$. Then the breaking pressure P in a direction normal to the tooth surface is as follows:

$$P = \frac{1}{6} \times \frac{l\beta}{360} \times T^2 \times \frac{S}{0.3683p} = 0.000314l\beta p S \text{ pounds. (1)}$$

To determine the number of teeth N_c which are in contact simultaneously, referring to Fig. 1 we have:

$$N_c = \frac{2}{p} \sqrt{\frac{D^2}{4} - \frac{D^2}{4} + 0.35Dp - 0.12p^2} = \sqrt{\frac{1.4Dp}{p^2}} = 1.18 \sqrt{\frac{D}{p}} \text{ (2)}$$

where D = pitch diameter of worm-wheel in inches.

Dropping the quantity $0.12p^2$ in deriving Formula (2) makes this a rather coarse approximation, but that it serves its purpose will be shown in the following discussion. Wilfred Lewis has shown (see MACHINERY'S HANDBOOK, page 594-596) that the permissible working stress in the material of gear wheels varies almost inversely as the square root of the peripheral speed. Applying this to the tensile strength factor S , and assuming a working stress of 20,000 pounds per square inch for a peripheral speed of 100 feet per minute, we have:

$$S = 20,000 \sqrt{\frac{100 \times 12}{\pi D \times \omega}} = \frac{392,000}{\sqrt{D \times \omega}} \text{ pounds per square inch (3)}$$

* For previous articles on worm-gears and worm-gear design see "Making High Efficiency Worm-Gearing," January, 1914, and other articles there referred to.

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where ω = number of revolutions per minute of worm-wheel.

$$l = \frac{\pi d}{\cos \alpha} \text{ inches (4)}$$

where l = length of worm thread per revolution;

d = pitch diameter of worm in inches;

α = angle of lead of worm thread.

Multiplying Formula (1) by Formula (2) gives the total breaking pressure P_1 in pounds. Performing this operation we have:

$$P_1 = 0.000314 \times 1.18 l \beta p S \sqrt{\frac{D}{p}}$$

Inserting the values from Formulas (3) and (4) and assuming $\beta = 70$ degrees, we have:

$$P_1 = 0.000314 \times 1.18 \times 3.14 \times 70 \times 392,000 \times \frac{dp}{\cos \alpha \sqrt{pD \times \omega}} = 32,200 \times \frac{d}{\cos \alpha} \sqrt{\frac{p}{\omega}}$$

The preceding formula gives the value of the pressure acting in a direction normal to the surface of the teeth. Multiplying by $\cos \alpha$ gives the tangential pressure P_2 at the pitch line which is required to break the teeth.

$$P_2 = 32,200 d \sqrt{\frac{p}{\omega}} \text{ pounds. (5)}$$

To determine the pressure P_3 which is required to break down the oil film between the worm-wheel and worm, the method of procedure is as follows: The length of the con-

tact line l per tooth is $\frac{\pi d}{\cos \alpha} \times \frac{\beta}{360}$, and from Formula (2) the number of teeth N_c which are in contact at the same time is

$$1.18 \sqrt{\frac{D}{p}}$$

Then the total length of the contact line L is:

$$L = 1.18 \times \frac{\pi d}{\cos \alpha} \sqrt{\frac{D}{p}} \times \frac{\beta}{360} \text{ (6)}$$

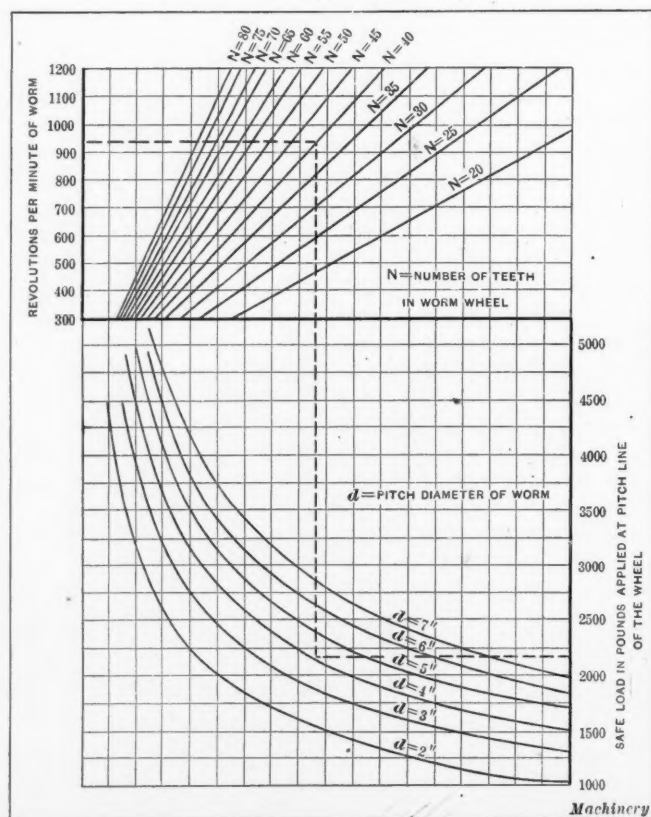


Fig. 2. Diagram for determining Safe Load for Steel Worm and Bronze Worm-wheel

The pressure per inch of contact line necessary to break down the oil film between the teeth varies with the "rubbing" speed. With the experimental gears which were used in obtaining the data presented in this article, the load was increased to the "seizing point" for different rubbing speeds ranging from 200 to 1000 feet per minute, and curves were plotted with "seizing loads" as ordinates and speeds as abscissae. In each case it was found possible to replace these

curves with one of the form $P = \frac{C}{\sqrt{V}}$, where C is a constant; and that by so doing the error did not exceed ± 5 per cent. This shows that within the speed range referred to, the pressure per inch of contact line may safely be regarded as inversely proportional to the square root of V .

Combining Formula (6) with the general formula for the pressure per inch of contact line we have:

$$P_s = C_1 \times \frac{d}{\cos \alpha \sqrt{V}} \sqrt{\frac{D}{p}}$$

where C_1 is a constant including all constants in Formula (6) and the constant C for the general formula for the pressure per inch of contact.

The value of the rubbing speed V is:

$$V = \frac{\pi d \omega_1}{12 \cos \alpha}$$

$$\cos \alpha = \frac{\pi d}{\sqrt{9.8d^2 + K^2 p^2}}$$

Combining the preceding equations we have:

$$V = 12 \times \omega_1 \sqrt{9.8d^2 + K^2 p^2} \quad (7)$$

where ω_1 = revolutions per minute of the worm;

K = number of threads on worm.

Multiplying the value for the seizing pressure P_s by $\cos \alpha$ and inserting the value of the rubbing speed V from Formula (7), gives the tangential seizing pressure P_t .

$$P_t = C_2 \times d \sqrt{\frac{N}{\omega_1 \times \sqrt{9.8d^2 + K^2 p^2}}}$$

In deriving the preceding formula it must be remembered that $\frac{\pi D}{p} = N$ = total number of teeth in worm-wheel. For values of the constant K less than 3, we have the value of the seizing pressure P_t as follows:

$$P_t = C \sqrt{\frac{d \times N}{\omega_1}} \quad (8)$$

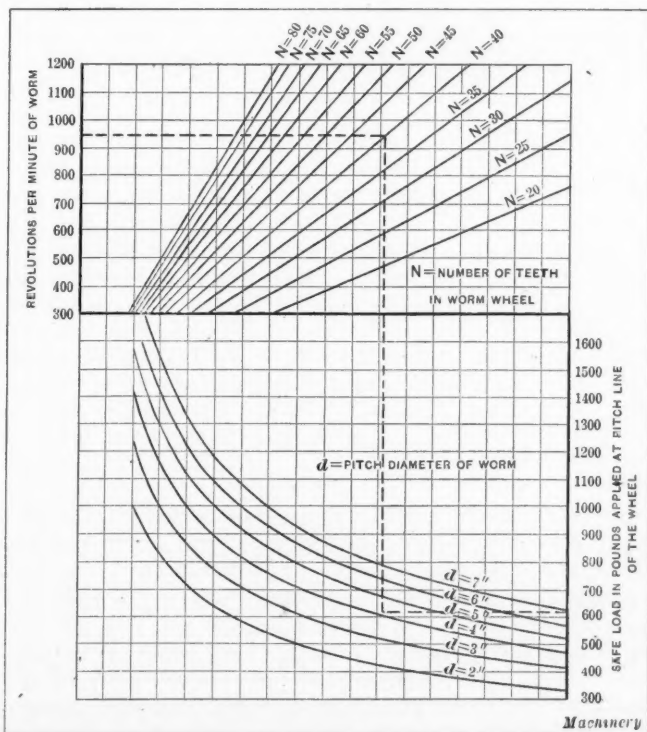


Fig. 3. Diagram for determining Safe Load for Steel Worm and Iron Worm-wheel

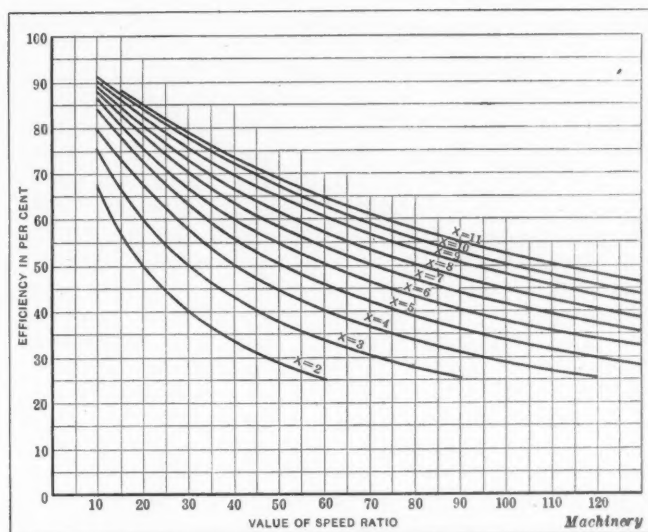


Fig. 4. Diagram for determining Efficiency of a Worm-gear Drive

where the value of the constant C is unknown.

For the purpose of determining the value of the constant C of Formula (8), tests were conducted with four worms having pitch diameters ranging from $2\frac{1}{2}$ to $4\frac{1}{2}$ inches and pitches ranging from 0.8 to 1.5 inch. These worms were first run in contact with bronze worm-wheels with pitch diameters ranging from 8 to 30 inches; and after these tests were completed, a second series of tests was conducted running the worms with iron worm-wheels of the same dimensions. A high grade of cylinder oil was used as a lubricant while using the bronze worm-wheels. For the tests in which the iron worm-wheels were used, a mixture of one pound of graphite in two gallons of cylinder oil was employed. The points at which the break-down of the oil film and consequent "seizing" of the gear teeth took place were apparent by the sudden drop of efficiency. In the tests where the iron worm-wheels were used, the seizing point was also readily distinguished by the sound. The worm-wheels were taken from a line of standard B. & S. elevator gears. The worms were neither ground nor tempered, but the worm-wheels were hobbled. The value of the constant C was found to average 15,600 for bronze worm-wheels, and 4350 for iron worm-wheels. These figures are based upon an oil temperature of 90 degrees F; but where the temperature of the oil was 65 degrees F. the values of the constant C were found to be 15 per cent higher.

Now to find whether the value of the breaking pressure P_b from Formula (5) or the seizing pressure P_s from Formula (8) is the limiting pressure, we may consider them as equal. Thus for the bronze worm-wheels:

$$32,200d \sqrt{\frac{p}{\omega}} = 15,600 \sqrt{\frac{dN}{\omega_1}}$$

Solving the preceding equation for the value of p we find:

$$p = 0.24 \frac{\omega d N}{\omega_1 d^2} = \frac{0.24 N}{R d} = \frac{0.24 K}{d} \quad (9)$$

where R = speed ratio $\frac{\omega}{\omega_1}$;

$K = \frac{N}{R}$ = number of threads on worm.

It will be evident from Formula (9) that when the pitch is less than one-quarter of the ratio $\frac{\text{number of threads}}{\text{pitch diameter of worm}}$ it is necessary to investigate the mechanical strength. Worm-gears of small pitch are often subjected to a severe strain in practice and the seizing pressure P_s , the value of which is expressed by Formula (8), is the limit load. The charts shown in Figs. 2 and 3 were developed to facilitate the application of Formula (8). The chart shown in Fig. 2 is made up with the data secured from tests with bronze worm-wheels, using a factor of safety of 3. Thus from

Formula (8) $P_s = 5200 \sqrt{\frac{dN}{\omega_1}}$. Similarly, the values for the

chart for iron wheels, shown in Fig. 3, are calculated by substituting in the formula $P_s = 1450 \sqrt{\frac{dN}{\omega_1}}$. Both charts

will give values which are too high if the number of threads on the worm is greater than 2. Thus for $K=4$, the maximum error will be about 5 per cent. To use either of the charts for a given gear, start at the ordinate in the upper section, which represents the proper number of revolutions per minute of the worm, and follow the horizontal line to the diagonal representing the proper number of teeth; then follow the vertical line down to the curve in the lower section of the chart representing the pitch diameter of the worm in question; and from this curve follow the horizontal line to the right-hand side of the chart where the safe load is found. The dotted lines are drawn for a 40-tooth worm-wheel running at 940 revolutions per minute, with a worm of 4 inches pitch diameter. Following this line in the two charts, it will be found that the safe load which can be applied to the pitch line of the bronze worm-wheel is 2150 pounds; and for the iron wheel, the safe load is 610 pounds. The writer has used these charts for a long while and has found them reliable for use in rating worm-gears for intermittent service. If the charts are used for rating worm-gears giving continuous service, it is necessary to ascertain that the temperature of the oil in which the gears run does not exceed the value specified on the chart.

In the efficiency test on the gears referred to, the writer found Prof. Barr's formula for the efficiency of worm-gears including the thrust collar on the worm to give results that were from 3 to 7 per cent lower than the maximum measured values; but the test curves give steadily increasing values of efficiency from no load up to the "seizing point." As the rated load is supposed to be only 33 per cent of the maximum load, the formula seems to be satisfactory for all practical purposes. The formula may be changed to a more convenient form as follows. The Barr formula for the value of the efficiency E is:

$$E = \frac{\tan \alpha (1 - f \tan \alpha)}{\tan \alpha + 2f}$$

where f = coefficient of friction = 0.05;
 α = helix angle of worm thread.

Using the preceding notation:

$$\tan \alpha = \frac{pK}{\pi d}$$

$$E = \frac{\tan \alpha (1 - 0.05 \tan \alpha)}{\tan \alpha + 0.1} = \frac{pK \left(1 - 0.05 \frac{pK}{\pi d} \right)}{\pi d \left(\frac{pK}{\pi d} + 0.1 \right)}$$

Multiplying the expression within both brackets by $\frac{\pi D}{pK}$ and bearing in mind that $\frac{\pi D}{pK} = \frac{\omega_1}{\omega} = R$, while $\frac{D}{d} = \frac{\text{pitch diameter of wheel in inches}}{\text{pitch diameter of worm in inches}}$ is designated by X , we get:

$$E = \frac{pK}{\pi d} \left(\frac{R - 0.05X}{X + 0.1R} \right) = \frac{pK}{\pi D} \times \frac{\pi D}{\pi d} \left(\frac{R - 0.05X}{X + 0.1R} \right) = \frac{X}{R} \left(\frac{R - 0.05X}{X + 0.1R} \right) \quad (10)$$

In practice, the quantity $0.05X$ is very small compared with the value of the speed ratio R and may usually be omitted from the formula without seriously impairing its accuracy. This reduces Formula (10) to the form:

$$E = \frac{X}{X + 0.1R} \quad (11)$$

Formula (11) will be found convenient if it is desired to determine the efficiency of a gear from its dimensions.

The results of the tests referred to showed that the iron worm-wheels gave a slightly greater efficiency than the bronze wheels, but the mixture of oil and graphite which was used

as a lubricant in testing the iron worm-wheels may have been partially responsible for this improved efficiency. The chart shown in Fig. 4 gives the efficiency for different values of the ratio X .

* * *

AN INSPECTOR'S STAMPING MACHINE

One of the inspectors at the Eclipse Machine Co.'s factory in Elmira, N. Y., has rigged up an inexpensive stamping machine for marking finished pieces with the lot number, etc. The illustration of the device, which is in reality a little bench press, shows that it is operated by a crank on the right-hand side of the machine; this crank turns a short shaft, the end of which may be seen at the left-hand side of the machine. On this shaft is a gear that engages a rack in the vertical slide of the fixture, and at the bottom of this slide is the stamp that makes the impression. The gear



Fixture for stamping Duplicate Parts

teeth on the pinion are cut away for three-quarters of the periphery, so that as the crank is turned the toothed section engages the rack and raises the ram until the last tooth on the gear lets go of the rack. Then as the rack runs into the open space the ram drops and stamps the work by gravity. As soon as the toothed section of the pinion comes around again, it picks the ram up and the operation is repeated. Adjustment is provided so that the letters may be stamped to any depth desired. A simple gage at the bottom serves to locate the work quickly, and the device may be operated continuously by simply turning the crank. The operator shown in the illustration has just finished stamping a lot of the small rings that may be seen in the foreground, and they were done at the rate of thirty pieces per minute, each one being evenly stamped and the impression uniformly located on the work.

C. L. L.

* * *

Commercial rubber which is kept in perfectly dry air will not deteriorate, but in the presence of sufficient moisture it may be attacked by certain bacteria; some of these do not sensibly alter the properties of the rubber, but others are able to modify its properties so as to destroy its value. The importance of keeping rubber as dry as possible is, therefore, apparent.

BASE METAL PYROMETER COUPLES

Within the past decade the pyrometer has become an indispensable adjunct of the heat-treating plant, and fortunately it is no longer necessary to use the platinum-rhodium couple which alone costs about \$60. The rare metal couple is costly, expensive to maintain and may be stolen because of the high intrinsic value of the metals used. During the past few years, in which the pyrometer has come into common use for testing the temperature of furnaces and molten metals up to 2000 degrees F., base metal couples have been successfully substituted for the rare couples formerly universally used. The base metal couples cost from one-seventh to one-tenth as much as the platinum-rhodium couples, and when the hot ends are burned off, they can be re-welded at a nominal cost and made as good as new. The construction of the common platinum-rhodium couple is such that it is practically non-repairable.

Another advantage of the base metal couple is its high electromotive strength. A base metal couple made by one well-known concern generates approximately 44 millivolts with temperatures of 77 degrees F. at the cold end, and 1950 degrees F. at the hot end, while the platinum-rhodium couple generates only about 10 millivolts with the same temperature difference. The base metal couple has an approximately straight-line electromotive force relation with the temperature, whereas the metal couple does not. This gives it the advantage of even scale divisions which obviously are more easily and correctly read by the average workman than uneven scale divisions. Because of the high millivoltage, it may be used with the rugged high-torque double-pivot type voltmeter that may be read without leveling, which is the only type suitable for shop use.

The base metal couple has an almost negligible temperature coefficient, whereas that of the rare metal couple is high. This feature of the base metal couple is also an advantage, as it eliminates what is known as the "immersion error." Hence the base metal couple pyrometer can be used bare in molten lead, aluminum and brass with good results. A noticeable portion of the couple is dissolved at each insertion, when used in molten brass, but though the welded end is soon eaten off, the couple can still be in use and give correct readings. One well-known make of base metal couple pyrometers has been used in molten brass for as many as two hundred readings, until the couple was too short to be handled.

* * *

The oxy-acetylene welding process has been used successfully for building up flat spots on locomotive driving wheel tires and restoring them to perfect condition. This means a substantial economy in the maintenance of locomotives and a saving of locomotive time in repair shops, which is of great importance during rush seasons. Instead of removing all the drivers of locomotives and turning them down to the common diameter made necessary by the depth of the flat spots, the flats are filled in with metal welded to the tire, and in a few hours the locomotive is ready for the road. The process saves tires, machining expenses and locomotive time.

INTERCHANGEABLE LOCATING AND CLAMPING ACCESSORIES

Everyone familiar with machine shops has noted the amazing number of bolts, straps, blocks, clamps, nuts and washers that accumulate around planers, milling machines, boring machines and other machines having a platen on which work is clamped for machining. Under some systems of shop management this mass of clamping accessories is relegated to the tool-room, from which it can be obtained on request as required for every job, but usually it will be found that there is a woeful lack of system in designing and dimensioning these very necessary parts of machine tool equipment.

Henry Lucas, of the Lucas Machine Tool Co., Cleveland, Ohio, has made a study of this vital subject for several years, and in cooperation with others in his organization has worked out a clamping outfit which seems to combine the maximum of efficiency with the minimum of parts. It is based on the unit principle, the idea being to get any height of block or any length of bolt required by using blocks or bolts of unit or multiple unit dimensions, building up to the required height or length.

The accompanying illustration, Fig. 1, shows a group of

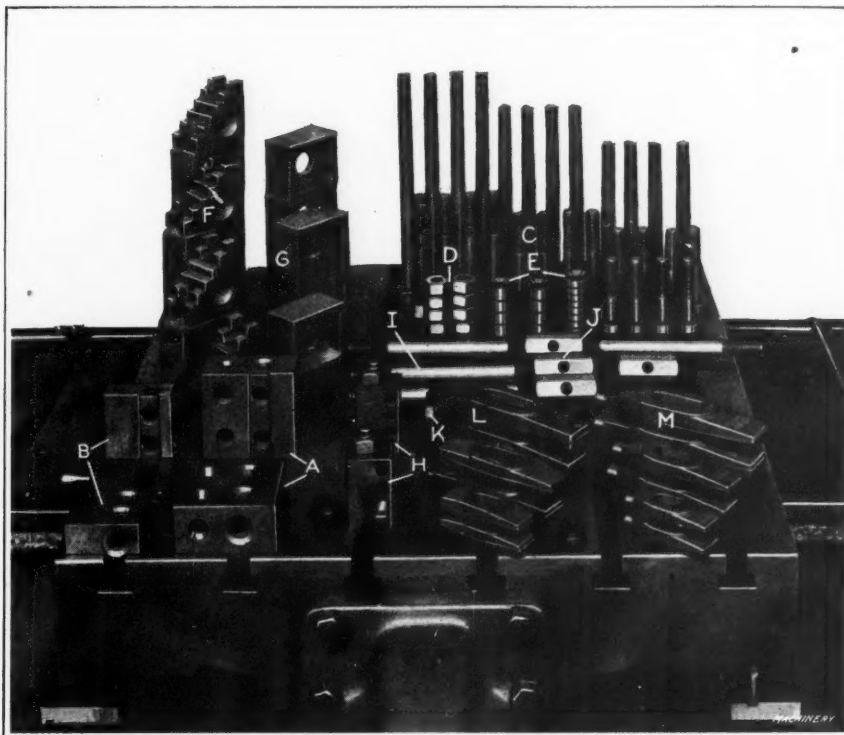


Fig. 1. Lucas Interchangeable Locating and Clamping Accessories for Machine Tools designed on Unit Principle

bolts, studs, washers, nuts, blocks, clamps, and stops which embody this principle and present a remarkable example of what can be accomplished in providing for all ordinary needs in clamping with a minimum number of parts. The clamping bolts $\frac{3}{4}$ inch diameter are threaded to the U. S. standard and have round heads, flattened, making two sides to engage the standard T-slot. The bolts have case-hardened threads, and the washers and nuts are also case-hardened. The nuts are rounded on both faces and the washers are cupped to fit. It will be noted that there are six lengths

of bolts at the back and short lengths in front, connected with hexagon couplings. These cover all lengths from the minimum to 12 inches, the nearest length being selected and over-lengths being taken up by thick and thin washers in the usual manner.

When a greater length is required than is provided for by the regular bolts, a regular bolt and a stud or studs are coupled together with the couplings to make up the length desired. The couplings are made of hexagon stock, drilled and tapped clear through. A lateral hole is drilled through the middle to show the machinist the position of the bolt ends so that he can engage the coupling threads equally on the two studs being connected.

The clamps are the regular drop-forged clamps made by one of the drop-forge concerns. These are provided in two styles, regular and pointed, the latter being used where a hole in the casting is to be engaged.

The blocking follows out the same general scheme of the clamp bolts. There are four blocks of each height, and the stepped blocks provide any small increment needed to accommodate a casting height, the height of the steps being one-half inch. A feature of these stepped blocks not common to stepped blocks in general is a slot in each side and base. The slot is provided to straddle a bolt in a narrow space. It often

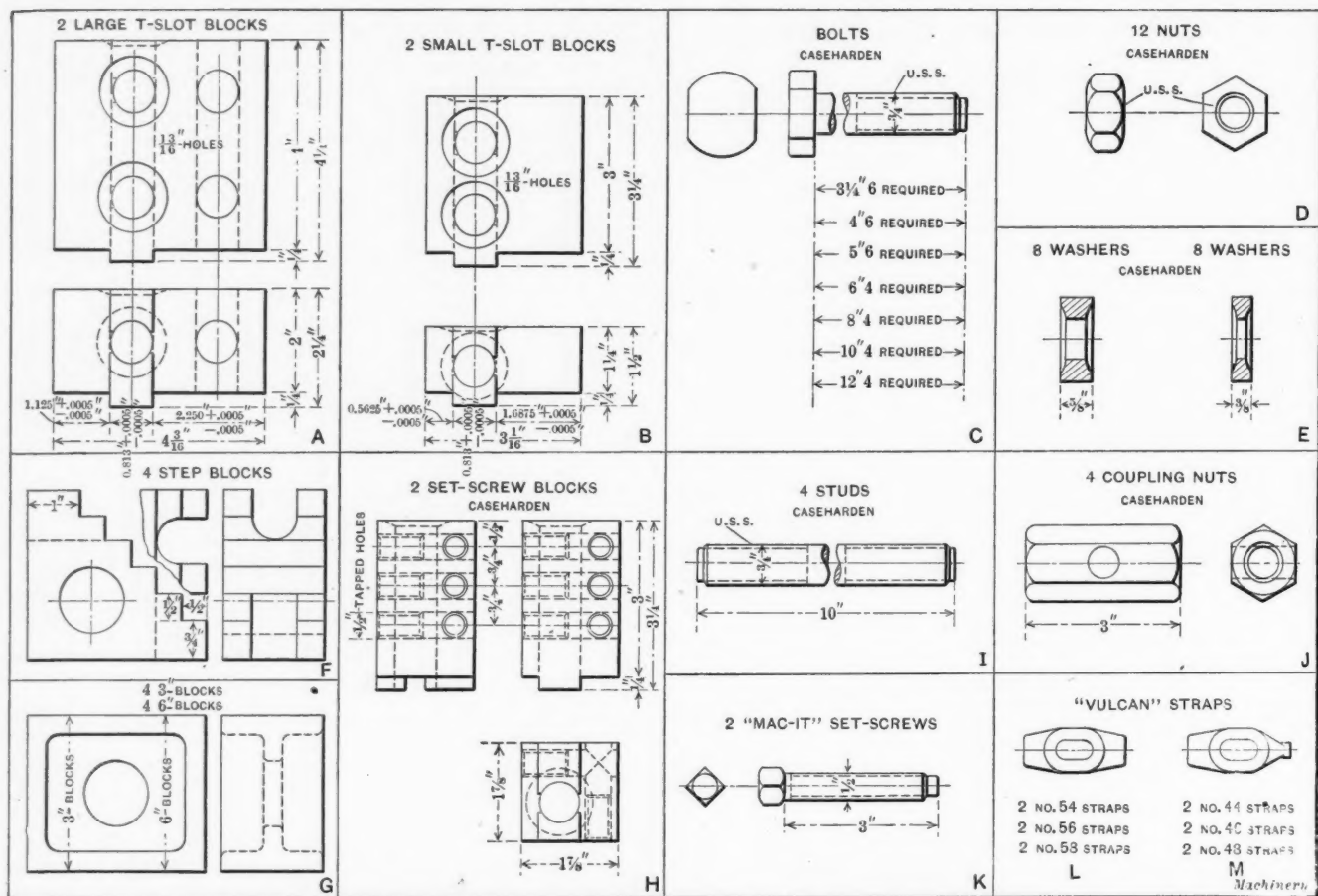


Fig. 2. Specifications of a Set of Lucas Locating and Clamping Accessories for Machine Tools

happens that a stepped block is needed in a space too narrow for the regular stepped block; this form will go into a narrow space because the legs straddle the bolt and reduce the space required by at least $1\frac{1}{2}$ inch.

The system has been carried out to include stops, and two forms are provided. The block type is made of cast iron planed with a rib to fit the regular T-slot of the machine. These blocks are clamped, using regular clamping bolts and they may be used in a variety of ways as anchors for the clamp bolts where the latter cannot be used with the heads in the regular T-slots. The other form of stop is provided with set-screws facing in two directions. Three holes are tapped in both directions and set-screws are provided. An advantage of this type of stop, aside from its general convenience, is its secure attachment to the platen. It exerts no bursting or prying effect like that of the ordinary "jimmy" stop in common use.

A set of locating and clamping accessories as specified in Fig. 2 comprises the following parts:

- A—2 large T-slot blocks, 4 inches by $4\frac{3}{16}$ inches by 2 inches;
- B—2 small T-slot blocks, 3 inches by $3\frac{1}{16}$ inches by $1\frac{1}{4}$ inch;
- C—6 $\frac{3}{4}$ -inch bolts, $3\frac{1}{4}$ inches long under the head;
- C—6 $\frac{3}{4}$ -inch bolts, 4 inches long under the head;
- C—6 $\frac{3}{4}$ -inch bolts, 5 inches long under the head;
- C—4 $\frac{3}{4}$ -inch bolts, 6 inches long under the head;
- C—4 $\frac{3}{4}$ -inch bolts, 8 inches long under the head;
- C—4 $\frac{3}{4}$ -inch bolts, 10 inches long under the head;
- C—4 $\frac{3}{4}$ -inch bolts, 12 inches long under the head;
- D—12 $\frac{3}{4}$ -inch casehardened nuts;
- E—8 casehardened washers, $\frac{3}{8}$ inch thick;
- E—8 casehardened washers, $\frac{5}{8}$ inch thick;
- F—4 step blocks;
- G—4 3-inch blocks;
- G—4 6-inch blocks;
- H—2 set-screw blocks, casehardened, $1\frac{7}{8}$ by $1\frac{7}{8}$ by 3 inches;
- I—4 $\frac{3}{4}$ -inch studs, 10 inches long;
- J—4 coupling nuts, casehardened, 3 inches long;
- K—2 "Mac-it" set-screws, 3 inches long under the head;
- L—2 each Nos. 54, 56, and 58 "Vulcan" straps;
- M—2 each Nos. 44, 46 and 48 "Vulcan" straps.

Suppose a casting to be clamped on a boring machine platen is $16\frac{3}{4}$ inches high, and is so shaped that clamping must be done at the top on one end, but at the other end a foot pro-

jects that is $2\frac{1}{2}$ inches thick. Various combinations can be effected with the bolts, studs and coupling nuts to clamp at the height of $16\frac{3}{4}$ inches, but say that a 10-inch bolt coupled to a 10-inch stud I, using a coupling nut J, are selected. The available length under the head when the bolt end and stud meet in the coupling nut is 20 inches, which gives ample room for the "Vulcan" strap, nut and washer on top, and the length required below the table top to engage the T-slot. Two 6-inch blocks surmounted by a 3-inch block G and a step block F furnish the requisite height of blocking to support the other end of the clamp which should rest on the third step of the step block to be level. It will be noticed that the step blocks are so made that increments of $\frac{1}{2}$ inch in height are afforded, the first step in one case being $\frac{3}{4}$ inch and 1 inch at the other end. Hence, any height within limits can be built up with no variation greater than $\frac{1}{4}$ inch. The projecting foot of the casting $2\frac{1}{2}$ inches thick is clamped with a 4-inch bolt, using a clamp, washer and nut, and a step block supporting the outer end of the clamp on the third step; the side as shown in the illustration F is then the base.

F. E. R.

* * *

Experiments have been undertaken in Germany with a view to determining whether boron would have a beneficial influence on iron and steel. The reason for this inquiry probably was that it had been discovered that boron has an extremely beneficial influence on copper; in fact, copper can be cast satisfactorily only by the addition of boron. It is also known that boron added to certain metals is valuable in preventing acid attacks, and a series of tests was made along this line also. In the tests on cast iron, it was found that the acid-resisting qualities were somewhat increased, but boron had a bad effect on the mechanical properties of the iron, so much so, in fact, as to outbalance any advantages. The hardness and brittleness of the cast iron increased in rising proportion as the percentage of boron increased. When added to steel, ingots with boron became brittle, piping became more pronounced, and the first blows with the hammer developed cracks. Bending tests were also impossible as cracks developed immediately. The results of the tests, hence, were that for practical purposes boron additions to steel and cast iron are of no value.

ESTABLISHING NUMBER OF OPERATIONS FOR DRAWING CYLINDRICAL SHELLS

DIRECT METHOD OF DETERMINING DRAWING DIE DIAMETERS AND NUMBER OF OPERATIONS BY THE USE OF CHARTS

BY FRITZ J. W. SPARKUHL*

WHEN laying out or constructing dies for drawing cylindrical shells, the diemaker is confronted by the following questions: What should be the diameter of the first-operation die? Assuming that more than one operation is required, what should be the diameters of the redrawing dies? How many operations will be necessary for producing a shell of the required diameter and depth? If the diemaker is entirely in the dark regarding the properties of the metal to be drawn, he must depend principally upon his own experience or that of someone else, and the result is that the common and often very expensive way of determining die sizes by repeated trials is resorted to, the diameters of successive dies being increased or diminished as may be found necessary. This method, of course, results in a considerable waste of time and material and, in some cases, the die parts are spoiled. In order to avoid trouble of this kind, or at least decrease the amount of trouble and unnecessary expense, the writer uses two formulas for determining the die diameters for shells of soft steel and tinplate, which are simple and at the same time give correct results. One of these formulas is for determining the diameter of the first-operation die and is as follows:

d = (X x D) / (100 - 0.635D)

The diameters of the redrawing dies are determined by the formulas:

d1 = (X1 x d) / (100 - 0.635d) and d2 = (X1 x d1) / (100 - 0.635d1) etc.

In these formulas

- D = the calculated blank diameter;
- d = diameter of the first-operation drawing die;
- d1 = diameter of redrawing die;
- d2 = diameter of following redrawing die;
- X and X1 = factors which depend upon the thickness of the metal to be drawn.

These factors X and X1 for different thicknesses of stock are given in Table I. The numerical values of these factors

TABLE I. MINIMUM AND MAXIMUM VALUES FOR DIE-DIAMETER FORMULAS

Metal Thickness, Inch	First-operation Die X		All Redrawing Dies X1	
	Minimum	Maximum	Minimum	Maximum
0.016 to 0.018	61	68	74	81
0.02	58	65	73	80
0.022 to 0.024	56	63	72	80
0.028	54	60	71	79
0.03	50	56	70.5	77
0.06	47	53	70	75
0.12	51		65	

were found by making several hundred trial draws, using different blank and die diameters and different thicknesses of stock. It should be mentioned that the results are correct only for dies used in double-action presses where the blank-holder pressure is constant and, in the case of redrawing dies, inside blank-holders having 45-degree drawing edges are employed. The method of determining these factors is indicated in Table II, which shows the results of a number of trial drawing operations. As will be seen, the blank diameter for a given die diameter was gradually increased, or, in other words, the ratio of die diameter / blank diameter was decreased until the rupture of the shell occurred. For instance, when

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this ratio was equal to 61.5, the drawing was excellent, but when the blank had been increased until the ratio equalled 50, the shell was completely torn by the drawing operation. In this manner, several hundred tests were made on various thicknesses of stock with different die and blank diameters and the results carefully noted. These tests showed that the ratio of die diameter / blank diameter for the same thickness of metal is not constant (assuming that the same quality of drawn work is obtained in each case), but that the increase of blank diameter means an increase in ratio; in other words, the diameter of the first drawing die should be proportionately larger as the diameter of the blank increases. For instance, by referring to Table II, it will be seen that a ratio of 53.5 represents the drawing limit when drawing a blank 3 3/4

TABLE II. RESULTS OF TRIAL DRAWING OPERATIONS TO DETERMINE RATIO BETWEEN DIE AND BLANK DIAMETERS

	Blank Diameter D	Die Diameter d	Ratio d/D, Per Cent	Remarks
Metal Thickness, 0.018 inch. Radius of Drawing Edge, 1/8 inch.	1 3/8	1 1/8	61.5	Drawing excellent
	1 3/8	1 1/4	58.5	Drawing good
	1 3/8	1 1/2	55.8	Some good, some bad
	1 3/8	1 5/8	51.5	Few good, mostly torn
	1 3/8	1 7/8	50.0	Completely torn
	2 1/8	2 1/8	68.0	Drawing excellent
	2 1/8	2 1/4	63.0	Drawing good
	2 1/8	2 1/2	57.0	Drawing limit
	2 1/8	2 3/4	53.5	Some good, mostly bad
	2 1/8	2 7/8	51.5	Torn
Metal Thickness, 0.02 inch. Double-action Press, Radius of Drawing Edge, 1/8 inch.	1 3/4	1 1/4	62.5	Drawing excellent
	1 7/8	1 1/2	62.0	Drawing excellent
	1 7/8	1 3/4	61.0	Drawing good
	1 7/8	1 7/8	58.5	Drawing good
	1 7/8	1 7/8	57.0	Stretching
	1 7/8	1 7/8	55.0	Some good, some bad
	1 7/8	1 7/8	52.5	Torn completely
	1 7/8	1 7/8		

inches diameter in a 2-inch die, some shells being good but most of them bad. Practically the same result was obtained when drawing a 1 3/4-inch blank in a 3 1/8-inch die with a ratio of 51.5, which shows that a larger blank requires a comparatively larger die than a smaller blank.

It will be noted that some of the blank diameters in the table are given to sixty-fourths of an inch. These exact dimensions are listed merely because they happened to be the diameters of the blanks which were cut out for these particular tests by the circle shear.

It is easy to calculate the diameters of the different dies by the formulas given, but as the factors X and X1 have minimum and maximum values, it is rather difficult to determine the exact number of drawing operations that might be required in any case, and in order to facilitate this work the accompanying series of charts was laid out. After the required blank diameter has been determined, these charts show graphically what the diameters of the dies should be and the number of operations necessary to produce a given shell. Doubtless the best way to demonstrate the practical application of these charts is by means of an example. Suppose the dies for a cylindrical shell 4 1/4 inches in diameter and 5 3/4 inches high are to be made and that the thickness of the metal is 0.02 inch. First it is necessary to determine the blank diameter. This may be done by means of the well-known formula D = sqrt(d^2 + 4dh). There is also the mensurative graphical method which is based on the rule of Guldinus, D = sqrt(8RL), and also the weighing method D =

1.128 * sqrt(W/w). In these formulas:

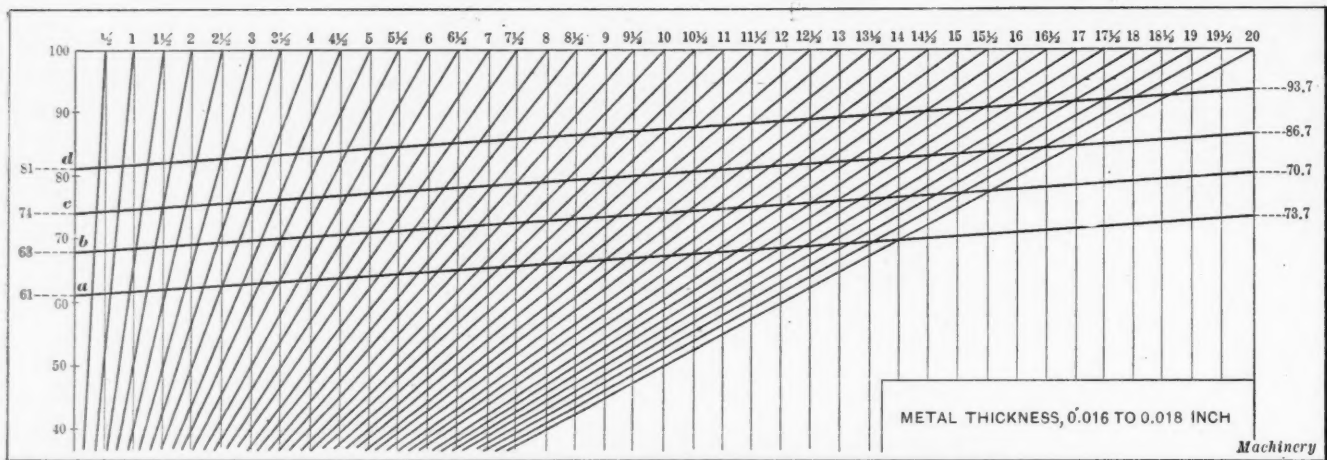


Fig. 1. Chart for determining Drawing Die Diameters for Given Blank Diameters

D = blank diameter;
 d = shell diameter;
 h = height of shell;
 L = length of generating line;
 R = distance from center of gravity of L to central axis;
 W = weight of shell in pounds;
 w = weight of metal per square inch.

All of these formulas are based on the supposition that the area of the blank diameter equals the area of the shell and that thin metal is used so that the thickness of the shell wall does not change to any appreciable extent.

referred to are for different thicknesses of metal; for a thickness of 0.02 inch, the chart shown in Fig. 2 should be used. The blank diameters are given along the horizontal line at the top of the chart. As the diameter in this case is $10\frac{1}{2}$ inches, this figure is located and then the diagonal line should be followed until the area between the cross lines a and b is reached. The intersection of the vertical lines (drawn from the horizontal diameter line at the top of the chart) and the diagonal line A within the area between lines a and b gives the minimum and maximum diameters for the first-operation die. In this case the minimum and maximum

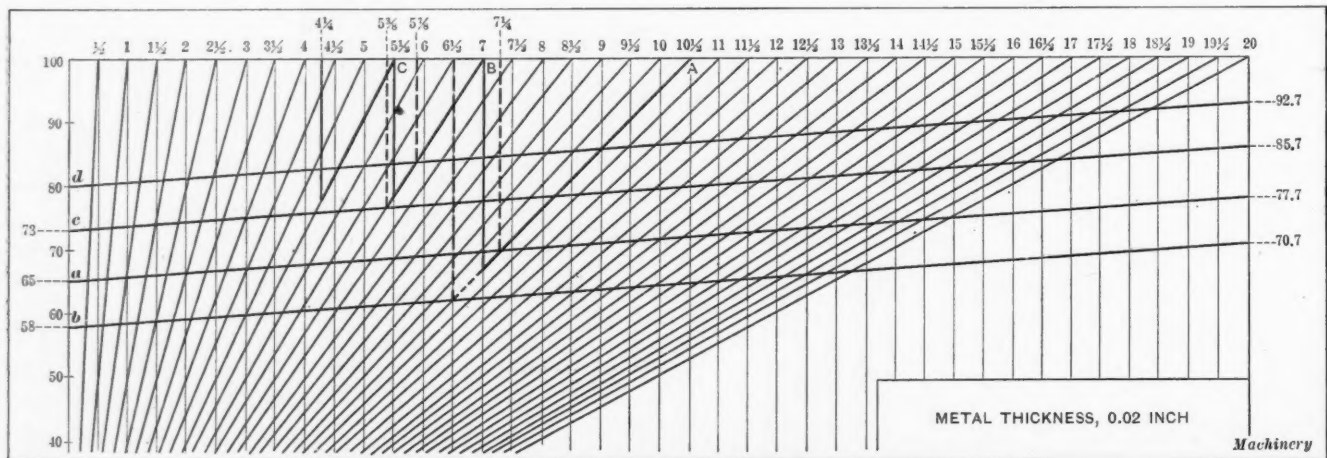


Fig. 2. Chart for determining Drawing Die Diameters for Given Blank Diameters

The blank diameter for a shell of the size given in the foregoing is found to be $10\frac{1}{2}$ inches, allowing sufficient metal for trimming. This is, of course, a trial diameter and should not be used for the blanking die. The exact size of the blank must be established by trial after the drawing dies are made; ordinarily, it will be found that the calculated blank diameter is large on account of the stretch of the metal when drawing. As will be seen, the charts previously

diameters are $6\frac{1}{2}$ and $7\frac{1}{4}$ inches, respectively, as shown by the dotted vertical lines; thus, we have a minimum die diameter of $6\frac{1}{2}$ inches, below which it is not advisable to go because of the danger of obtaining imperfect work. On the other hand, it would not be economical to use a die larger than $7\frac{1}{4}$ inches because it would be larger than necessary and an extra redrawing die might be required; hence, a diameter of 7 inches is selected for the first-operation die.

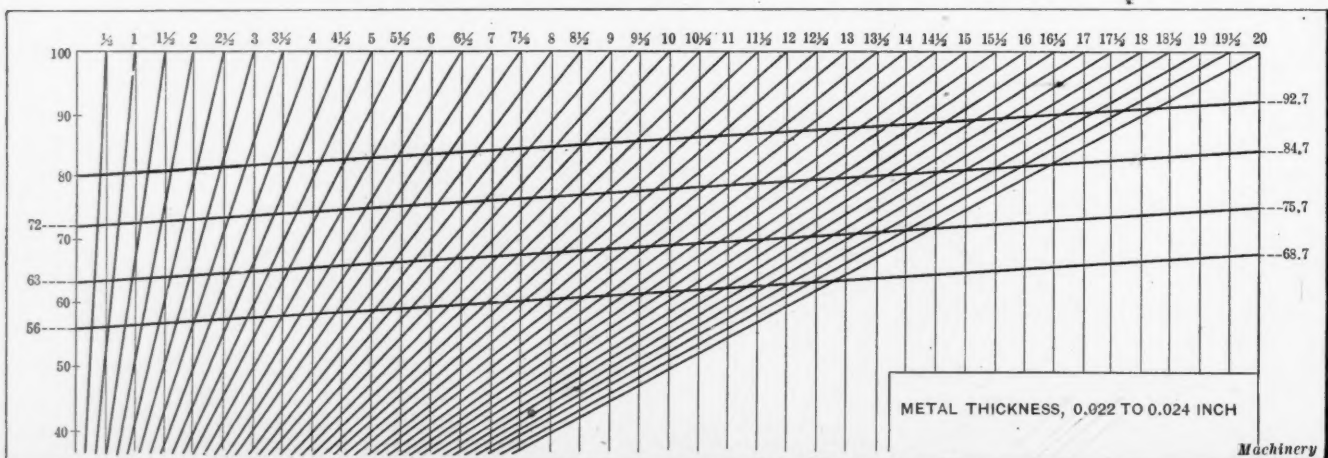


Fig. 3. Chart for determining Drawing Die Diameters for Given Blank Diameters

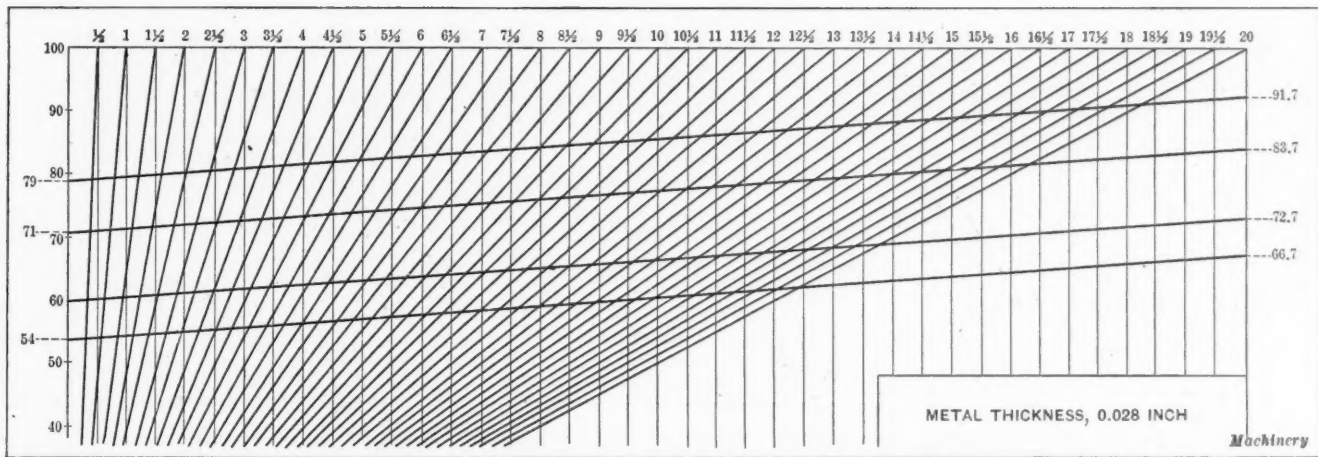


Fig. 4. Chart for determining Drawing Die Diameters for Given Blank Diameters

In order to find the diameter for the redrawing die, the diagonal line *B* from the 7-inch point is followed down to the space between the upper set of lines *c* and *d*. The intersection points with the vertical lines within this area give the minimum and maximum diameters of $5\frac{3}{8}$ and $5\frac{7}{8}$ inches, respectively, as indicated by the second set of dotted vertical lines. As the full line shows, $5\frac{1}{2}$ inches is selected as the diameter for the first redrawing die. Now, if the diagonal line *C* leading from the $5\frac{1}{2}$ -inch point intersects with a vertical line leading to $4\frac{1}{4}$ inches (the required shell diameter) between the lines *c* and *d*, the diameters of the two

cannot always tell at first which diameter to choose within the minimum and maximum limits represented by the space between the lines *a-b* and *c-d*. This point is illustrated by the following example:

Suppose a shell is to have a diameter of $1\frac{1}{2}$ inch, a height of $2\frac{7}{8}$ inches and that metal 0.02 inch thick is to be used. In how many operations is it possible to produce this shell? The example is illustrated graphically by the special chart, Fig. 8, which represents the corner of the chart shown in Fig. 2, and is drawn on an enlarged scale. The points marked A_1 , A_2 , A_3 show that a shell can be drawn in three operations,

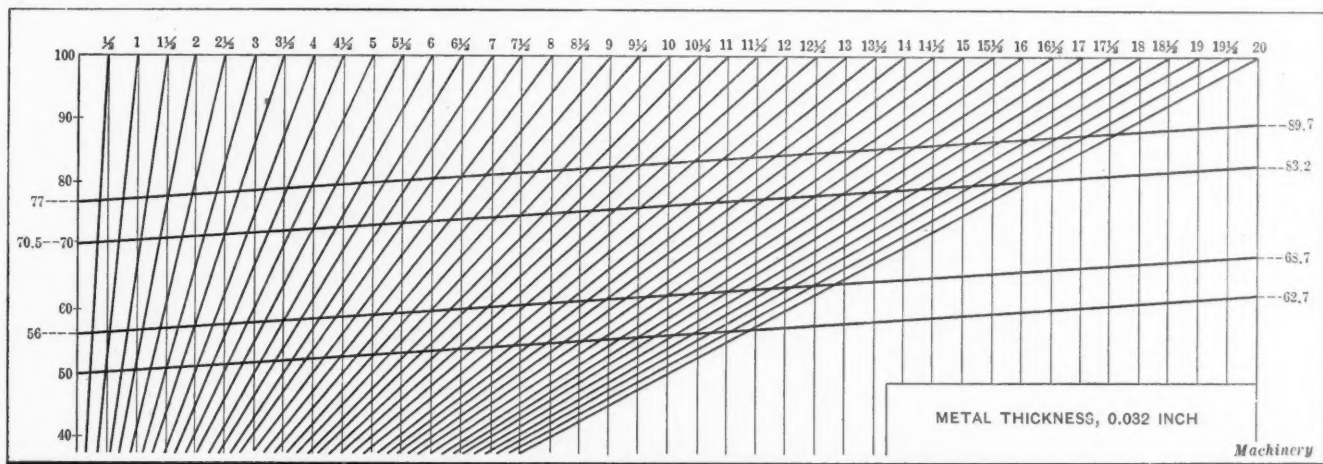


Fig. 5. Chart for determining Drawing Die Diameters for Given Blank Diameters

preceding dies are correct. If the intersection point should be below line *c*, this indicates that the diameters of the first or cupping die and the first redrawing die should be decreased. On the other hand, if the diagonal line should intersect the $4\frac{1}{4}$ -inch vertical line (or the one representing the finished size of the shell) at some point above line *d*, this would indicate that the first and second dies were smaller than they should be to obtain the best results. In some instances, one

the first die having a diameter of $2\frac{11}{16}$ inches, the first redrawing die a diameter of 2 inches and the finishing die a diameter of $1\frac{1}{2}$ inch. Points *B* and the dotted lines, however, show that the shell should be drawn in four operations, the die diameters being 3 inches, $2\frac{3}{8}$ inches, $1\frac{7}{8}$ inch and $1\frac{1}{2}$ inch, respectively. When three dies are used as indicated by the full lines on the chart, it will be noted that the points of intersection with the vertical lines are, in every case,

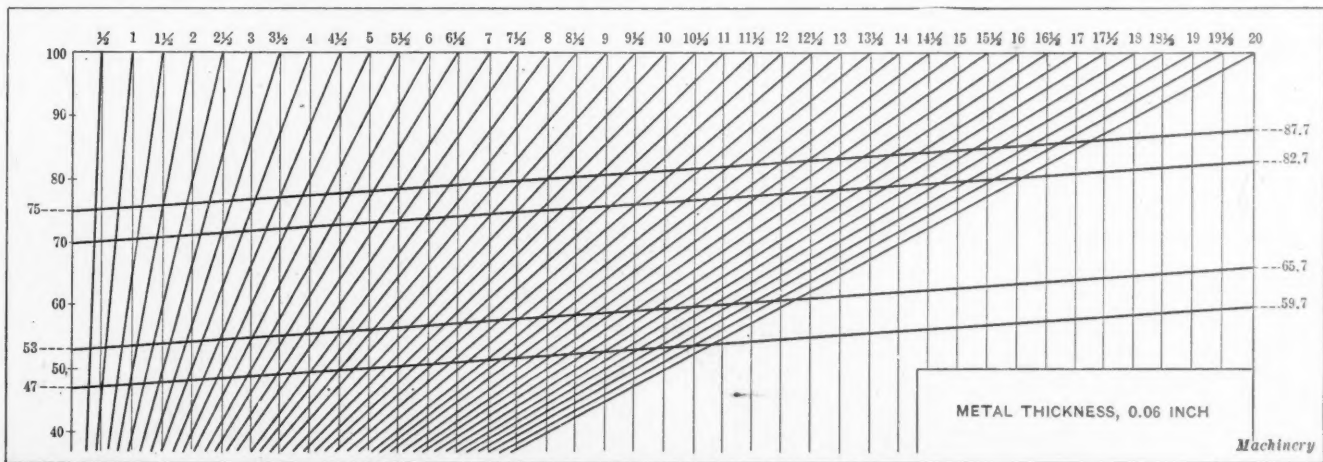


Fig. 6. Chart for determining Drawing Die Diameters for Given Blank Diameters

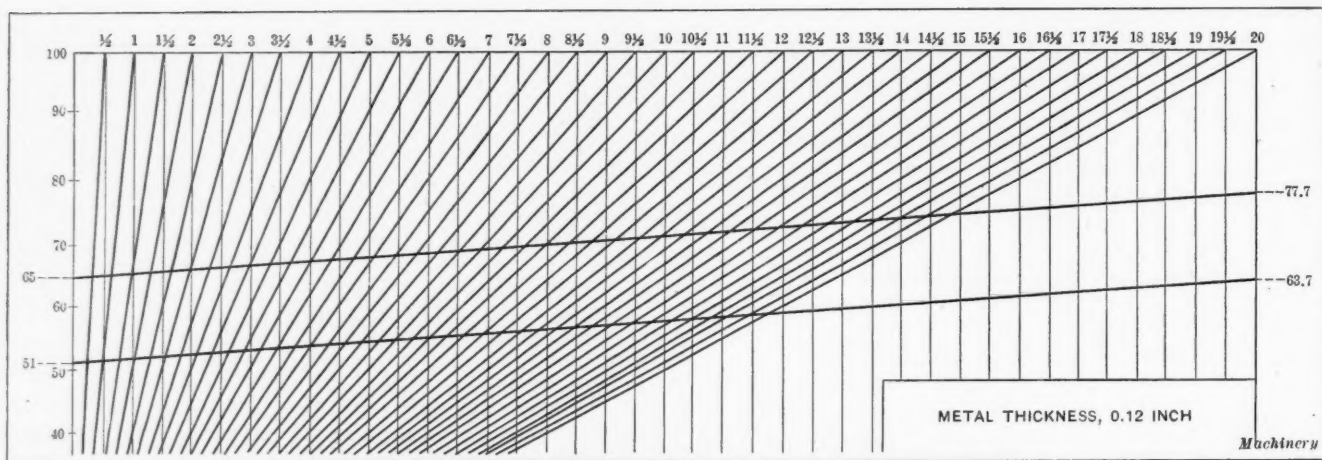


Fig. 7. Chart for determining Drawing Die Diameters for Given Blank Diameters

just above the cross line on the chart representing the maximum reduction. Therefore, if three dies are used, the metal must be of the very best quality, and it will doubtless be necessary to anneal the shell after each drawing operation, as otherwise the metal will not stand the strain. For this reason, it is advisable to use four dies instead of three. The extra die will soon pay for itself because less annealing will be necessary and the danger of breaking the shells is also avoided.

Perhaps the connection between the formulas previously given for determining the die diameters, and these charts, will be more apparent by applying the formulas to the example given in connection with the chart shown in Fig. 2. As previously explained, this chart shows that for a cylindrical shell $4\frac{1}{4}$ inches in diameter, $5\frac{3}{8}$ inches high (requiring a $10\frac{1}{2}$ -inch blank), the dies should have diameters of 7, $5\frac{1}{2}$ and $4\frac{1}{4}$ inches, respectively, with minimum and maximum values as represented by the dotted vertical lines. According to the

$$X \times D.$$

formula, the diameter of the first die $d = \frac{100 - 0.635D}{58 \times 10.5}$.

Taking the minimum value of X as 58 (as shown by Table I, for a metal thickness of 0.02 inch), $d = \frac{100 - 0.635 \times 10.5}{58 \times 10.5}$

$= 6.5$ inches minimum diameter, approximately. When using

the maximum value X of 65, $d = \frac{100 - 0.635 \times 10.5}{65 \times 10.5} = 7\frac{1}{4}$

inches maximum diameter, approximately. As will be seen, these results conform to those indicated by the chart. The minimum and maximum values of $5\frac{3}{8}$ and $5\frac{7}{8}$ inches, respectively, for the redrawing die also conform to formula

$$d_1 = \frac{X_1 \times d}{100 - 0.635d}$$

the minimum and maximum values of X_1 being 73 and 80, as given in Table I for this particular thickness of stock. It is evident that the use of these formulas or charts will eliminate much of the trouble connected with the designing and construction of drawing dies, especially when more than one operation is required. Incidentally, the drawing surfaces of the dies should be smooth and well lubricated. The blank-holder pressure should be constant and great enough to prevent the blank from wrinkling, a uniform metal should be used and it is very important that the press should be rigid enough to prevent any appreciable springing action during the drawing operation. The drawing velocity is another important factor, although avail-

able data on this subject are unreliable and indefinite, as every tool designer and diemaker knows.

* * *

NOVEL ELECTRIC VEHICLE

Harry E. Dey, an electrical engineer of New York City, has invented a three-passenger runabout electric car weighing about 1200 pounds, that embodies a new idea in electric motor design. The entire driving mechanism is made a part of the rear axle, thus eliminating a considerable number of shafts, gears and other parts necessary in electric motor vehicles as now made. There is no separate motor suspended under the car and no differential. The field and the armature of the motor revolve in opposite directions, reducing gears being interposed, so arranged, of course, that both wheels are driven in the same direction. Thus the electric motor acts as its own differential and, besides, its power per unit of weight is doubled for a given armature revolution speed. For example, in an ordinary motor the armature might revolve at 1500 R. P. M., the field standing still. In this case, however, the field coils would revolve in the opposite direction at the rate of 1500 R. P. M., giving the equivalent revolution speed of 3000 turns per minute. Another feature of the new electric vehicle is provision by which the motor acts as a brake when descending steep hills. It becomes a generator and charges the batteries instead of wasting the potential energy in wearing out brake bands.

* * *

NEW PROCESS FOR MAKING GASOLINE

A technical expert, Dr. Walter F. Rittman, chemical engineer of the Bureau of Mines, has discovered a process for increasing the output of gasoline from petroleum 200 per cent or more. With the steady increase in demand for gasoline for automobiles, motor boats and engines, this discovery is most important. It was but two years ago that the automobile industry, fearful that the supply of gasoline might not be adequate for its rapidly expanding business, offered through the International Association of Recognized Automobile Clubs, a prize of \$100,000 for a substitute for gasoline that would cost less than gasoline. Happily, the urgency of this situation has passed, and at the present time there is a plentiful supply of motor fuel to meet immediate demand, but this new process adds to the hope that in spite of the wonderful growth in the use of gasoline, there may not be any shortage in the future. It indicates an increased production of gasoline from the present production of petroleum—an output of 50,000,000 barrels instead of 25,000,000 yielded by present methods.

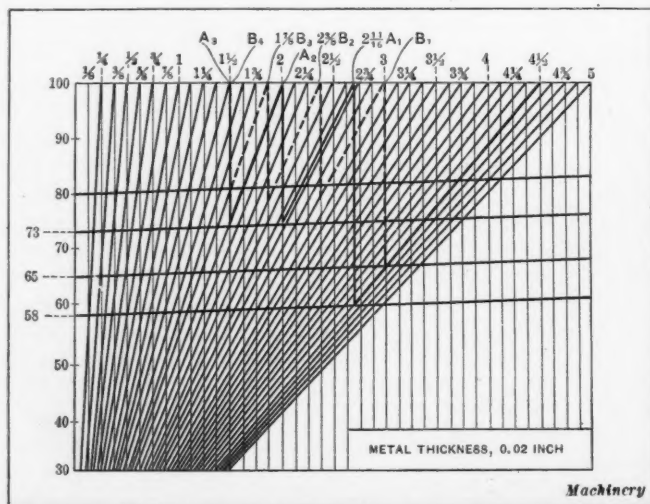


Fig. 8. Section of Chart shown in Fig. 2

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Infringement of Machine Patent

(U. S. Supreme.) The United States Supreme Court in the case of *Dowagiac Mfg. Co. v. Minnesota Plow Co.* has held that in an action for the infringement of a machine patent, no damages can be recovered by the original patentee for lost sales, where, although the number of machines sold by the defendant was shown, there was no proof that the patentee thereby lost the sale of a like number of machines, or of any definite or even approximate number, and where, during the period of infringement, several other manufacturers were selling machines in large numbers in the same localities in direct competition with the plaintiff's machine and under the evidence it could not be said that, if the sales in question had not been made, the defendant's customers would have bought from the plaintiff rather than from the other manufacturers, and where it did not satisfactorily appear that the plaintiff possessed the means and facilities requisite for supplying the demands of its own customers and of those who purchased the infringing machine. (*Dowagiac Mfg. Co. v. Minnesota Plow Co.*, 35 Sup. Ct. 221.)

Recovery of Property Sold

(Federal.) When a buyer being insolvent induces a seller to sell him machinery on credit, which he does not intend to pay for, the seller may rescind and recover the property. The United States Circuit Court of Appeals has so held in the case of *In re Marks & Co.* The court in commenting on the case said:

The law is well settled that when a party, being insolvent, induces another to sell him goods on credit which he does not intend to pay for, the court may order the contract disaffirmed and restore the property. Three propositions must be established by the claimant before he can rescind the contract and recover the goods: First, the insolvency of the bankrupts at the time the purchase was made. Second, the concealment from the claimant of the fact of insolvency. Third, intention on the part of the bankrupts, at the time of the sale, not to pay for the goods. (*In re Marks & Co.*, 218 Fed. 453.)

Duty to Warn and Instruct in Use of Machinery

(Federal.) When a servant is taken by the master from his ordinary employment and put at work at a machine which he has never used before, there rests upon the master the duty of instructing the servant with respect to the methods and the dangers of the machine, and such duty is an absolute one, for the performance of which the master is personally responsible.

Plaintiff, who was employed as an unskilled workman in defendant's works, was set to operate planer fixed in a table for planing boards. He had never done such work, and at the very beginning his hand was caught by the machine and injured. There was a guard fixed above the machine for the protection of the operator, but plaintiff was not instructed as to its purpose or mode of adjustment. While the foreman showed him how the machine was operated and gave him certain instructions, there was a conflict of testimony as to their nature and extent, and as to whether the guard was properly placed. Held: The duty of the master to instruct the servant as to the operation of the machine is an absolute one.

Under the Pennsylvania factory law requiring the use of safety appliances on dangerous machines, the avowed purpose of which is "to provide for the safety of all employees in industrial establishments," a "proper guard" on a dangerous machine means, not merely the presence of a proper guard on a machine, but that it shall be so used and adjusted as to be effective, and the failure of the master to comply with both of such requirements constitutes actionable negligence. (*Freedom Casket Co. v. McManus*, 218 Fed. 325.)

Warranty by Manufacturer of Fitness of Machine for Purpose Intended

(Federal.) Plaintiff contracted to furnish and install for defendant at its laundry a water-softening machine; the understanding of the parties being that it was to be used for treating water from a well which had been sunk by defendant. A sample of the water was furnished to and

analyzed by plaintiff, and its hardness found to be what is technically called 35 degrees. Plaintiff then wrote into the contract a guaranty that the water, as per its analysis, "when properly treated in this softener, will be satisfactory for laundry purposes." Water taken from the well some months afterward, on analysis, showed a hardness of 79 degrees, and, while the machine would soften it, so much chemical was required as to render it unsatisfactory for laundry purposes. Held, that the warranty applied only to water of substantially the same degree of hardness as that previously analyzed, and not to any water which might come from the same well, and that the failure of the machine to satisfactorily soften water of 79 degrees of hardness was not a breach thereof. (*Wendell & Evans Co. v. Kennicott Co.*, 218 Fed. 622.)

Duty to Guard Premises

(Federal.) Where defendant railroad company maintained a machine shop on a lot six feet back from a much-traveled street in the city, and the moving machinery was visible from the sidewalk through a wide double door, which was kept open in summer, and such machinery was attractive to children passing the shop, defendant was under a common law duty to guard the premises that children should not approach the machinery and be injured.

Where plaintiff, a boy of six, wandered from the street through an open door and into defendant's machine shop, and was there accidentally injured, he was too young to be a trespasser, and the company maintaining the shop is responsible for an injury which the boy suffered. (*Chesko v. Delaware & Hudson Co.*, 218 Fed. 803.)

Delivery Within Reasonable Time Implied

(Federal.) Where written agreements by a manufacturer of brick-making machinery, whereby it sold certain machinery to a brick concern, and agreed to furnish complete working drawings for the construction of a patented kiln, and to license defendant to use such kiln, specified no time for delivery of the machinery, drawings, license, delivery within a reasonable time was implied, and what was a "reasonable time" depended on the circumstances of the particular case. The United Circuit Court of Appeals so held in *C. W. Raymond Co. v. Allegheny Valley Brick Co.*

The facts were that in March, 1911, the Allegheny Valley Brick Co. entered into a written contract with the C. W. Raymond Co. for brick machinery, kiln drawings, etc. The consideration was \$2500. The machinery was shipped and drawing and specifications sent in the latter part of May. The Allegheny Valley Brick Co. refused to pay the full amount of \$2500, claiming that the machinery concern had not performed the contract; that the delay in furnishing the plans, specifications, drawings and machinery was unreasonable. In the trial court, judgment was entered for the machinery concern in the amount of \$3250.50, this amount representing the contract price, freight, court costs and damages. The United States Circuit Court as the court of review affirmed the decision. The court said that the contract as entered into by the parties implied performance within a reasonable time, and that since diligence was used in filling the order as soon as it was received, the machinery being constructed after the order was taken, two months was a reasonable time within which to perform the contract. (*Allegheny Valley Brick Co. v. C. W. Raymond Co.*, 219 Fed. 77.)

Sale of Future Inventions

(New York.) A corporation which, at the time it employed an inventor, who was a large stockholder therein, as its manager, at a fixed salary and a percentage of the net profits, also purchased from him for an additional consideration the patents which had been granted to him for inventions, all applications pending, and inventions now made or to be made in the future, was entitled to assignments of the patents for inventions by the manager made thereafter, though they were not in contemplation at the time the contract was made, especially where the manager had made use of those inventions for the benefit of the corporation, without making any additional claim for them. (*Klauder-Weldon Dyeing Machine Co. v. Weldon*, 151 N. Y. S. 1068.)

Return of Imperfect Machinery

(New York.) Where a manufacturer of machinery, to be delivered to defendant and erected upon his land, delivered imperfect machinery, the defendant could return the property, or could notify the manufacturer to remove it at his own cost, and could hold the manufacturer for the expense of restoring his property after removal, or he could take the machinery out and store it at the manufacturer's expense. (*Smith v. Hedges*, 152 N. Y. S. 95.)

Lease of Machinery

(New York.) Where a machine was delivered to the lessee under a 99-year oral lease and one month's rent thereon paid, but thereafter the lessee surrendered possession for the purpose of allowing repairs to be made, and the lessor refused to redeliver, there was not such part performance as would take the contract out of the statute of frauds requiring a lease for a longer period than one year to be in writing, and permit the lessee to recover damages for its breach. (*Siegel v. Reece Buttonhole Machine Co.*, 152 N. Y. S. 192.)

Logging Company Responsible for Injury

(Arkansas.) A contract for the sale of a machine to a logging company provided that the price should include the services of a man to superintend and assist in the erection of the machine, and to instruct the buyer's employees in its operation. The seller sent one of its regular employees to do that work, and the logging company directed some of its employees, including the plaintiff, to assist him. While the operator was demonstrating the operation of the machine under the general orders of the logging company's manager and in his presence, it was overturned through the negligence of the operator, and plaintiff was injured. Held, that since the work which was being done was the logging company's work, and under its control, all engaged therein, even the operator, were its servants for that purpose, and the company was liable as master for the injuries to plaintiff. (*Arkansas Logging Co. v. Martin*, 173 S. W. 185.)

Warranty in Sale of Machinery

(Virginia.) Where machinery did not work to the satisfaction of the buyer, as warranted by the seller, who failed to make good his warranty, the buyer could rely on breach of warranty, though he could not arbitrarily or capriciously discard the machinery for breach of warranty.

Where a buyer of saw mill machinery, when sued for the price, set up only a claim for damages for breach of warranty and proved that the machinery was worthless, while the warranty was that it could do satisfactory work, and if not, that the seller would make it do it, and that the seller, though frequently called on, failed to make good his warranty, the seller could not as a matter of law limit the buyer's offset to the extent an expert witness said the cost would have been in making repairs necessary to put the machinery in satisfactory working condition. (*Ney et al. v. Wrenn et al.*, 84 S. E. 1.)

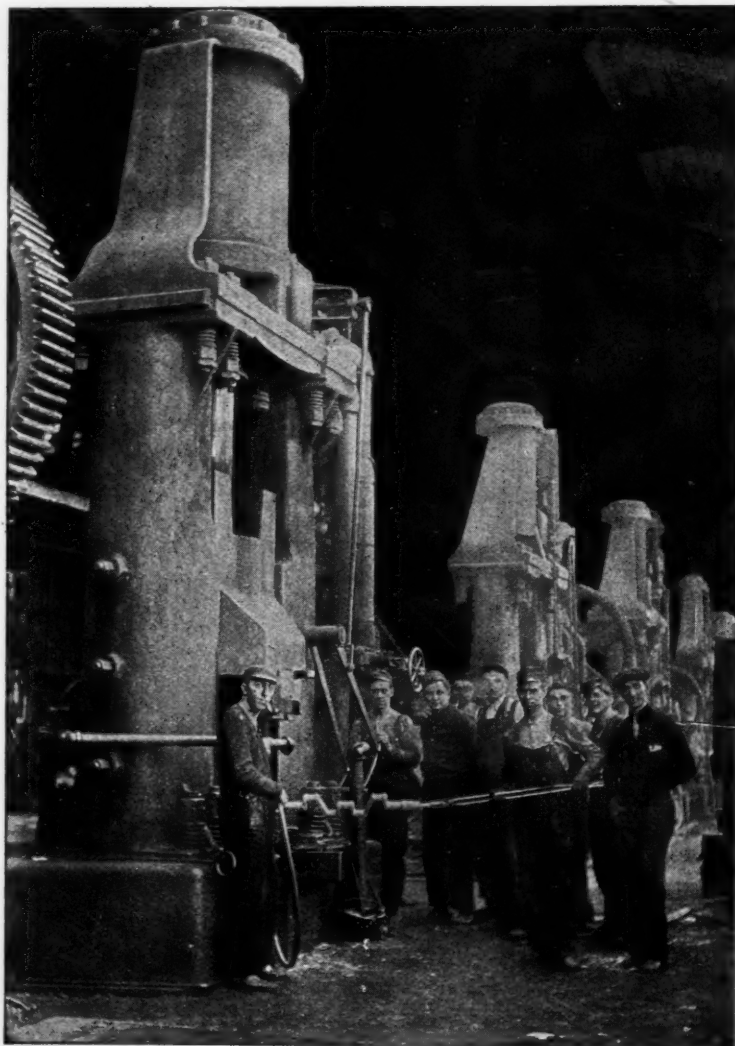
FORGING SIX-THROW MOTOR CRANKSHAFTS

The illustration shows an 18,000-pound steel frame drop-hammer built by the Alliance Machine Co., Alliance, Ohio, for the Buick Motor Car Co., plant of the General Motors Co., and installed in the Flint, Mich., forge shop at a cost of approximately \$18,000. It is used for forging six-throw crankshafts at one operation, the dies being so constructed that the bending, breaking down and forming of the three pairs of crankshaft throws 120 degrees apart are accomplished in one set of dies and at one heat. The advantage of forging the cranks at 120 degrees, over the usual process of forging them in one plane and then twisting to the desired required angular position, is that the cranks have little or no tendency to change position; while those forged in one plane and afterward twisted are likely to shift position in use, because of the internal stresses set up and not relieved by annealing.

* * *

AN EARLY SUBMARINE

In view of the important part now played in naval warfare by submarines, it is interesting to note that fifty-six years ago (January 14, 1859) the *Journal of the Royal Society of Arts*, to use its present title, contained an account of an invention for which it was claimed that "it would make such a change in the mode of carrying on a naval war as would put steamers out of the question, and render of no avail the tremendous forts of Kronstadt and Cherbourg. It is nothing less than a submarine boat, made only for working under water, in form much resembling the shape of a porpoise, but capable of being made large enough to contain eight, ten, or even fifteen men, if necessary, with a proportionate quantity of explosives." The patentee stated that he, with others, had submerged the boat in Lake Michigan, and remained under water for four hours, without any air tubes or other communications, and propelled the boat in and near the bottom of the lake for several miles at the rate of about three miles an hour. He claimed that he could convey powder torpedoes of 100 pounds weight in his boat, and when under an enemy ship pass them out



Forging Six-throw Motor Crankshafts at One Operation in the Buick Motor Car Co.'s Plant

of the side of his boat through his patent hatch, fasten them to the ship's bottom, and fire them. One of the most remarkable points about the description is that he appears to have used a periscope. "He can enter an enemy's harbor under water and make surveys, only showing above the surface a sight tube, not more than one-half inch in diameter, and retire still under water; he can then proceed out to sea and make his report to the commander of a fleet or ship."

* * *

The circular saw is said to have been invented by James Murray, of Mansfield, Nottinghamshire, England. The original saw was about six inches in diameter and is still in existence.

SPECIAL ELECTRIC BUTT-WELDING MACHINES*

APPLICATION OF ELECTRIC WELDING MACHINES TO THE WELDING OF TAP AND DRILL SHANKS, HOOPS, PIPE, CHAIN LINKS, WHEEL HUBS, ETC.

BY DOUGLAS T. HAMILTON†

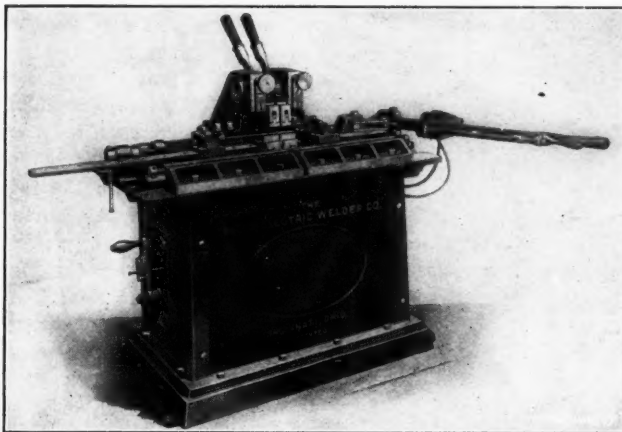


Fig. 1. Special "Toledo" Electric Butt-welding Machine designed particularly for welding such Work as Extension Taps, Twist Drills, etc.

AS has been mentioned in previous articles on electric welding, many classes of work can be most satisfactorily handled in machines designed especially for that purpose. To meet this demand, a large number of special electric welding machines have been put on the market, and in the following some of the most important of these will be illustrated and described.

Electric Welding Machine for Taps, Twist Drills, etc.

In making extension drills, taps, etc., use is made of the electric welding machine, and for this purpose special types of machines are usually built. Fig. 1 shows a machine designed for this work by the Toledo Electric Welder Co., Cincinnati, Ohio. In this machine, work which has been finished can be electrically welded so that the two finished parts will come together in perfect alignment. The machine has V sliding ways similar to those on a planer bed, which are scraped to a bearing and are provided with screw-adjusted long taper gibs, insuring accuracy in taking up wear of the moving parts. Stops with screw adjustments to back up and hold the work in perfect alignment are also provided. Each clamping lever is mounted on an eccentric that can be quickly adjusted for varying sizes of stock. The current is turned on by touching the thumb-switch mounted on the compression

* For further information on welding, see "Electric Butt-welding Practice" in the March and April, 1915, numbers of MACHINERY and article referred to in connection with the first installment.
† Associate Editor of MACHINERY.

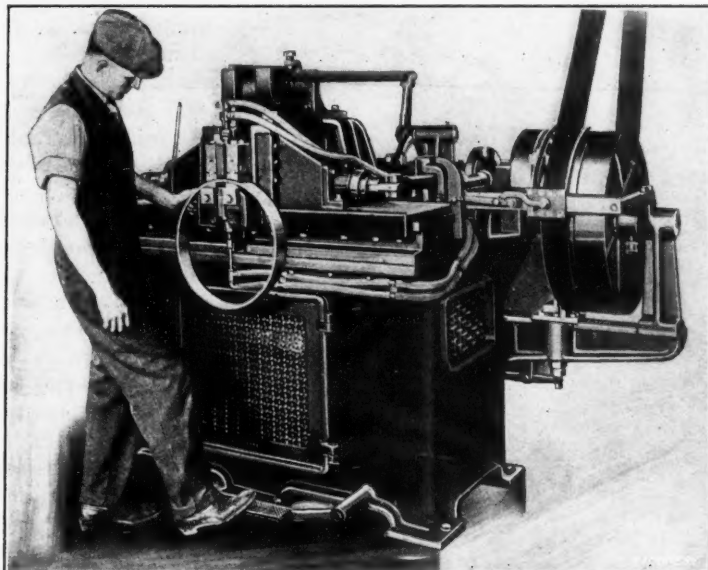


Fig. 3. Power-driven "Toledo" Automatic Butt-welding Machine especially designed for welding Hoops, having a Maximum Capacity of 2 by $\frac{3}{4}$ Inch and a Minimum Capacity of 1 by $\frac{1}{4}$ Inch Flat Stock

handle, and the clamping jaws are accessible and can be quickly changed for varying sizes of stock. The current regulator is mounted on the side of the machine and by means of this device the amount of current is under the complete control of the operator.

In welding extensions on taps or drills, the extension is usually made of low-carbon steel and the cutting part of the tool from high-carbon tool steel. To accomplish a satisfactory weld, it is therefore necessary to have the two materials protrude the proper distance from the faces of the clamping jaws. The amount that the work should project from the clamping jaws is governed by several conditions, and in this case would be governed largely by the diameter

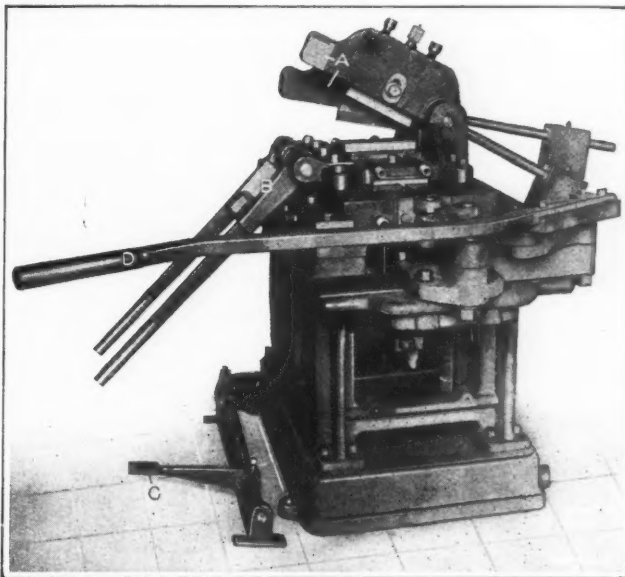


Fig. 2. Special Type of Electric Welding Machine built by the Thomson Electric Welding Co. for welding Automobile Rims and Similar Work

and carbon content of the parts being welded. Low-carbon steel, of course, does not offer as much resistance to the flow of electric current as does high-carbon steel, and consequently should project farther from the clamping jaws. For example, in welding a 15-point carbon shank to a 50-point carbon tap, the low-carbon extension should project about 1.8 times its diameter from the face of the clamping jaws, and the high-carbon part 0.625

times its diameter from the clamping jaws. The welding of shanks on taps and drills should be done very rapidly; that is, a large amount of current should be supplied, and the heating done quickly. A flash weld is also preferable to an upset weld.

Hoop and Tire Welding Machines

In changing over from cemented to clincher tires for automobile wheels, steel

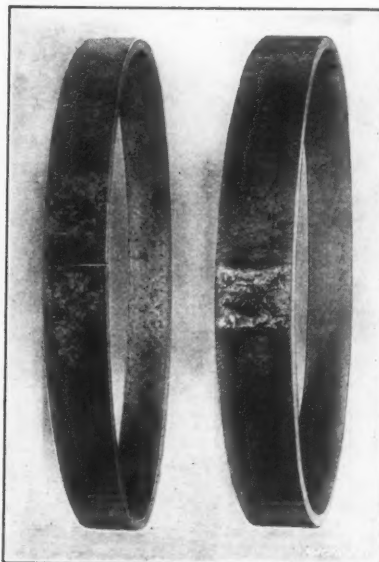


Fig. 4. Example of Hoop-welding performed on Butt-welding Machine shown in Fig. 3—Toledo Electric Welder Co.

instead of wooden rims were used. As a means of making steel rims cheaply, welded strip stock was adopted, and for handling this work special electric welding machines were devised. Fig. 2 shows an electric welding machine designed and built by the Thomson Electric Welding Co. for welding automobile rims. This machine will weld flat stock up to 7 inches wide by 5/32 inch thick, and has a capacity of 30 kilowatts for 15 seconds, or 125 kilowatt hours for 1000 welds. It is known

as a 30-kilowatt electric welder and is shown in the illustration with the clamps thrown open. In operating this machine, the hoop or rim is slipped in between the upper and lower clamping jaws with the ends of the rims abutting.

The two upper clamping arms A are then brought down in contact with the work, and the handles or clamps B swung up so as to hold them in position. The current is then turned on by depressing the foot treadle C and handle D is operated. This moves the platen and brings together the abutting ends of the rim which are now highly heated, forming a weld. The machine is supplied with adjustable replaceable self-hardening steel jaws in the upper arms, which are also provided with balancing weights so that as soon as the clamping levers are removed the upper jaws fly up. The platen is provided with ball bearings to facilitate its operation, and water is circulated through the secondary terminals and clamping jaws or electrodes to keep them cool.

Automatic Electric Tire Welding Machine

Electric butt-welding machines for welding automobile rims, hoops, etc., are made to be hand-operated or are of the semi-automatic type. A rim-welding machine of the semi-automatic type, built by the Toledo Electric Welder Co., is shown in Fig. 3. The stock is rolled into hoop shape and placed in the clamping jaws of the machine. The operator then depresses the foot-treadle shown at the front of the machine, whereupon the jaws instantly close and firmly grip the stock, bringing the ends of the hoop closely together. At the instant that the foot-treadle is operated, the current is automatically turned on and the stock begins to heat. In a few seconds it reaches the welding temperature, whereupon the operator again depresses the foot-treadle. This starts the machine, and the movable slide which is operated by a cam through connecting links and additional

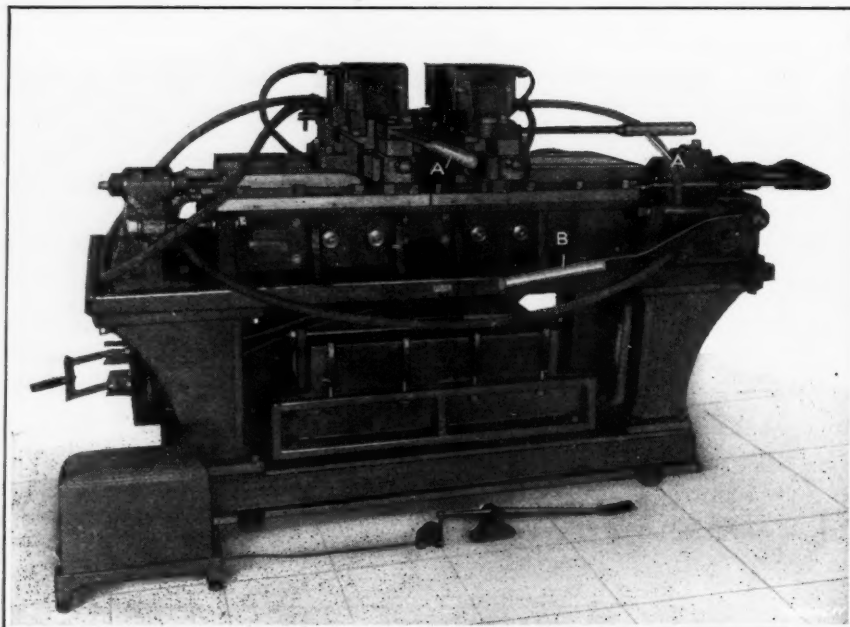


Fig. 5. 60-kilowatt Thomson Electric Welding Machine particularly adapted to the welding of Pipe and Tubing

then throws out the finished rim and places another in the machine, whereupon, the cycle of operations is repeated. The entire working mechanism of the machine is controlled automatically with the exception of the foot-treadle. The members of the machine that have to be varied for different classes of work are made adjustable, and when these have once been set in their correct position the operation is comparatively simple. An example of work handled in the semi-automatic rim-welding machine shown in Fig. 3 is illustrated in Fig. 4. To the left of this illustration is shown a rim previous to welding and to the right is shown a rim successfully welded. By looking closely at this illustration it will be noticed that the joint has been flattened out so that the thickness of the rim at the weld is very little greater than anywhere else along the circumference of the rim.

Machine for Welding Tubes and Pipes

Fig. 5 shows a pipe-welding machine built by the Thomson Electric Welding Co., which is capable of welding pipe up to 4 inches in diameter or boiler flues up to 5½ inches in diameter, and has a capacity of 60 kilowatts for 50 seconds, producing 100 welds with 83 kilowatt hours. This machine has water-cooled removable gun-metal clamps, into which the pipe is dropped. The movable slide is operated by a twelve-ton double-acting oil jack mounted at the right-hand end of the machine, and the break-switch for throwing the current off and on is controlled by a foot-treadle. In operation, the

tubing is either dropped into the clamping jaws or pushed through them until the two ends of the pipe meet midway between the jaws. Levers A are then drawn together, tightening the clamping jaws on the work. The foot-treadle is then depressed, turning on the current, and the ends of the pipe immediately begin to heat up. The jack lever B, operating the oil jack, is then moved up and down two or three times to force the molten ends of the pipe to-

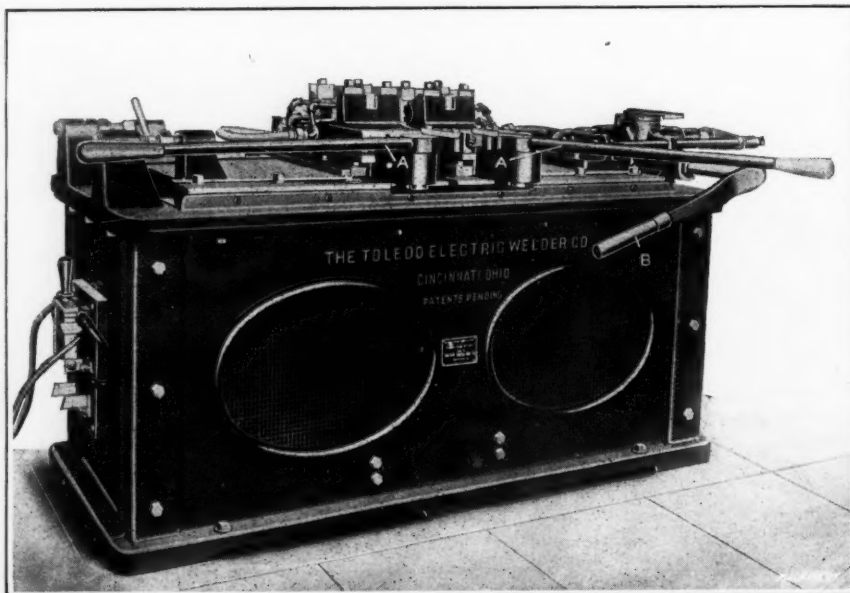


Fig. 6. Special "Toledo" Electric Butt-welding Machine designed especially for welding Extra Heavy Pipe up to 2 Inches in Diameter

gether. The foot-treadle is now released, shutting off the current; the clamping levers are thrown back and the tubing removed, leaving the machine ready for the next weld.

Another Pipe Welding Machine

Another type of pipe-welding machine which is designed and built by the Toledo Electric Welder Co. is shown in Fig. 6. This machine has a capacity for welding extra heavy pipe up to 2 inches in diameter, or round bar stock $1\frac{1}{4}$ inch in diameter. The maximum power required is 35 kilowatts. The machine is provided with vertical clamping jaws, which particularly adapt it for handling tubing. The work to be welded is clamped between the copper jaws by levers A. These levers operate similarly to a quick-acting eccentric vise. The work is placed in the two clamping jaws with its ends abutting. The current is then turned on by operating a foot-switch, not shown, and the stock quickly reaches a welding temperature. Two or three strokes of the pump handle B connected to the five-ton hydraulic ram then force the molten ends of the metal together to make a perfect weld. The clamping levers operate in a horizontal direction and do not interfere in any way with the pipe clamped in the jaws. These levers are long and are designed to clamp the stock so firmly that backing-up stops are not necessary when ordinary pipe is to be welded. The distance between the clamping dies can be regulated by means of adjusting screws located at the left-hand end of the machine. This allows the operator to set his machine for a certain amount of upset on the stock.

An example of welded work that can be handled on a tube-welding machine is shown in Fig. 7. This shows a piece of tubing welded to a stamping that is used for an automobile rear axle housing. In welding tubing to forgings, or tubing to tubing, a flash weld, as previously mentioned, is generally made, except in the welding of hydraulic or ammonia piping, where particular care must be taken to get a good weld without flash, as will be explained later.

Preparing Tubing for Welding

Tubing or piping that is to be welded should be cut square on the ends so as to abut evenly. To avoid having the upset decrease the inside diameter of the pipe, the abutting ends should first be flanged outward to a slight extent so that the ends when under pressure will force the upset to the outside. Instead of flanging the inside edges, one or both tubes can be chamfered slightly so that there will be a recess in which the upset metal can go. If tubing is rusty or scaly it should be brightened at those spots where it contacts with the clamping jaws and where it abuts. This can be done quickly on a grinding wheel. It is possible to weld tubing or ordinary pipe, and especially pipe with thick walls, by clamping the work in a V-shaped jaw, where but four points are

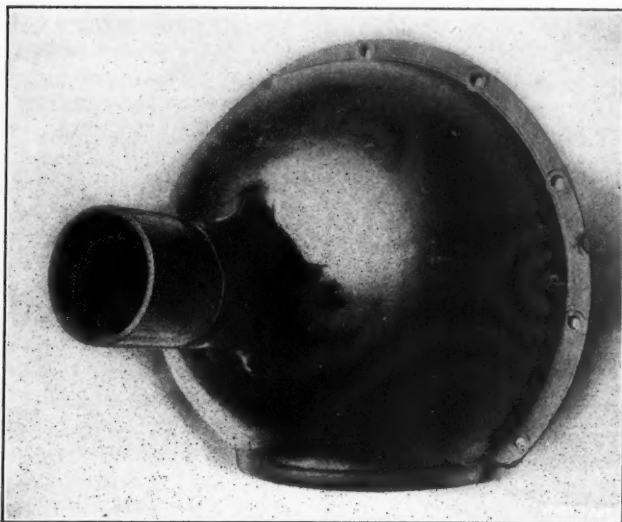


Fig. 7. Tubing welded to a Stamping; Weldings of this Character can easily be handled on Butt-welding Machines especially designed for this Work—Toledo Electric Welder Co.

special piping tongs to bring it to uniform size. By taking care, the inside of the pipe will show very little, if any, upset, and by inserting a mandrel inside the pipe at the time that it is being compressed with the tongs it can be made perfectly smooth.

Electric Welding Machine for Welding Chain Links

Another interesting application of the electric welding machine for manufacturing purposes is that employed in the welding of chain links. Fig. 8 shows a chain-link welding machine built by the Thomson Electric Welding Co. In this machine the work-holders are so constructed that they do not require manipulation prior to the operation of the machine. A mechanism is also provided for hammering the chain links after heating in order to reduce the burr or upset produced in the electric butt-welding operation.

Referring to Fig. 8, the chain links which are to be welded are clamped longitudinally and in a horizontal plane between the left- and right-hand clamping dies A and B with the open side of the links facing the rear of the machine and in line with the contact electrodes C, Fig. 9. The work-holders are firmly bolted in a suitable recess in the die slides, which can be adjusted to slide horizontally in a right and left-hand direction from each other. The left-hand slide D, which is normally held stationary, is mounted between guides formed on the table and is adjusted longitudinally by stop-screw E. The right-hand horizontal die slide F is actuated by a double toggle through a long hand lever G. The clamping dies H and I, Fig. 9, are provided with shallow link clamping recesses cut in their upper surfaces, and each of these recesses conforms substantially with the plane or out-

line of the links that are to be welded. The electrodes C can be moved sideways to contact with the work so as to draw the open end of the link together. The electrodes are actuated by a foot-treadle (not shown) through an equalizing yoke; this foot-treadle projects from the front of the machine near the floor. The double-ended lower hammer die or anvil J, which acts in conjunction with hammer K to flatten the flash formed at the welded joint, is a flat oblong

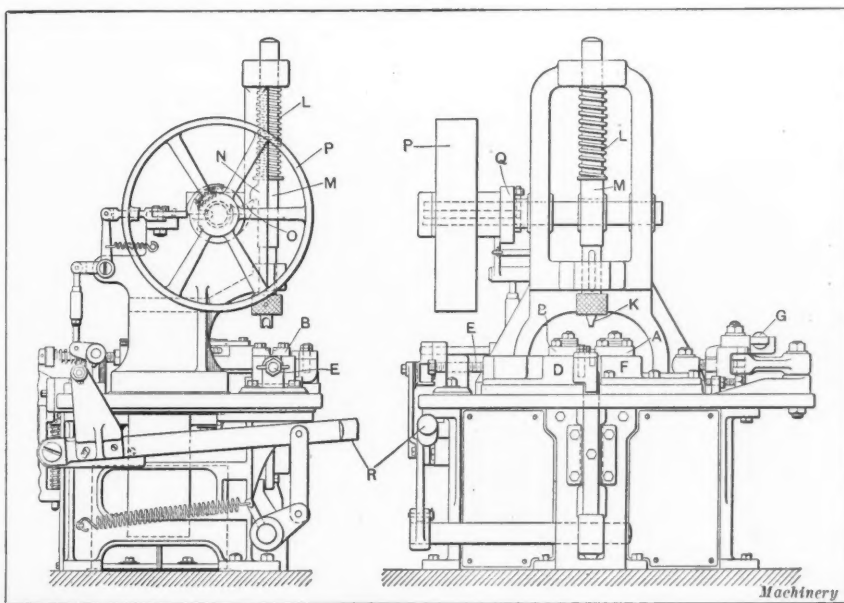


Fig. 8. Chain-welding Machine designed and built by the Thomson Electric Welding Co.

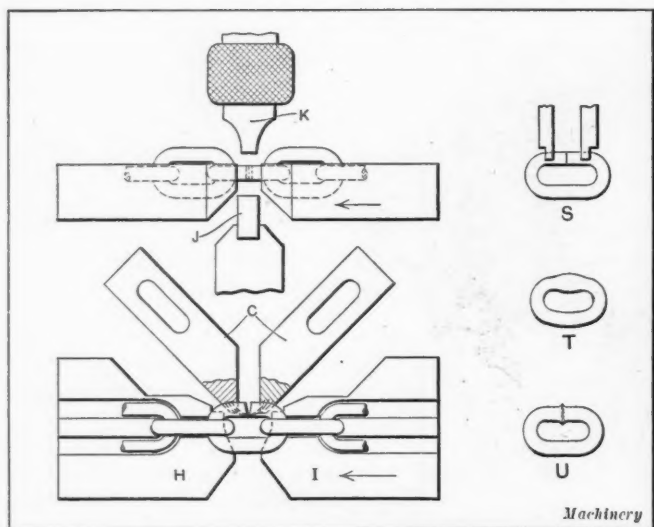


Fig. 9. Diagram showing Operation of Chain-welding Clamping Dies and Electrodes; also Results of Finished Work—Thomson Electric Welding Co.

piece of hardened steel mounted with its working end beneath the clamping position of the chain link. This anvil is made with interchangeable ends so that when one working end becomes worn or softened by contact with the heated chain link, it can be reversed and a new end brought into position. The hammer *K* is mounted directly above the anvil. A tripping device lifts the hammer against spring *L* and then releases it, the spring giving the required compression. The upper hammer *K* is held in the lower end of a vertically reciprocating die shaft *M* provided with a projection *N* that engages one or more actuating cams or dogs *O* mounted on the cam-shaft; these dogs lift shaft *M* against the tension of the spring *L*. Power is received from a flywheel *P* driven by a belt in the usual manner, which runs free until the clutch *Q* is engaged. The burr-reducing or link-finishing mechanism for both the anvil and hammer is controlled by hand-operated lever *R* extending across the left-hand side of the machine.

In operation, the link is centered and clamped between the holding dies, with its abutting ends just out of contact. These ends are then brought into contact by slightly increasing the pressure on clamping lever *G*. The contact electrodes *C* are

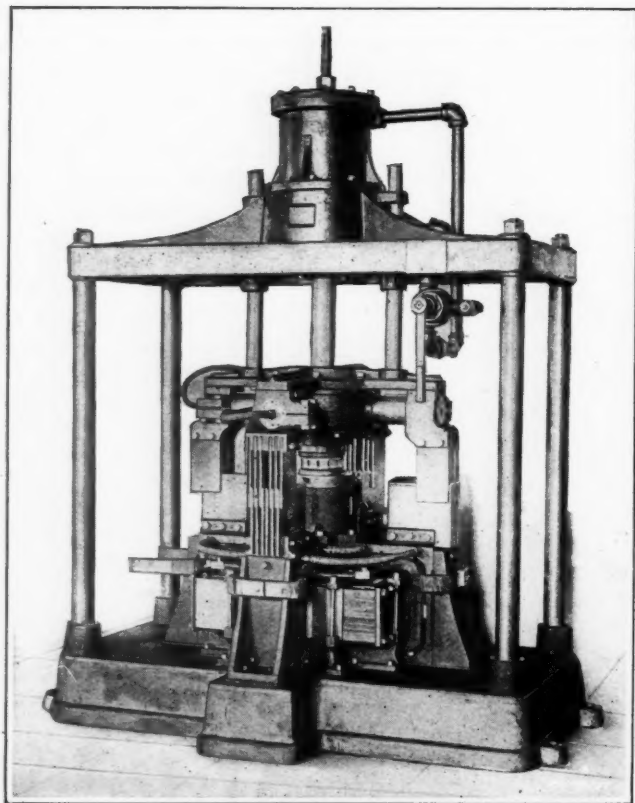


Fig. 10. Hub and Spoke Welding Machine designed by the Thomson Electric Welding Co.

then brought forward by pressure on the foot-treadle until they make contact with the side of the link which is to be welded. The primary circuit is then closed, thus producing a current in the secondary circuit or loop carrying the current to the electrodes. Meanwhile, the operator maintains an end pressure on the holding dies by means of the clamping lever. Since the contact of the open ends of the link is the greatest resistance in the circuit, the link rapidly heats up at this point and soon becomes plastic, spreading under the longitudinal pressure to which the abutting surfaces are subjected. As the ends of the link gradually upset, the operator quickly brings the holding dies closer together, thus completing the welding of the link. As clamping lever *G* reaches the position corresponding to the completion of the weld, the automatic current-controlling switch causes the circuit breaker to operate and shuts off the flow of the electric current. The manner in which the electrodes force the open ends of the link together is clearly illustrated in Fig. 9.

After the weld has been completed, the end pressure of the holding dies is maintained by the operator and the foot pressure on the treadle is released, permitting the contact electrodes to back away from the work. Lever *R* for operat-

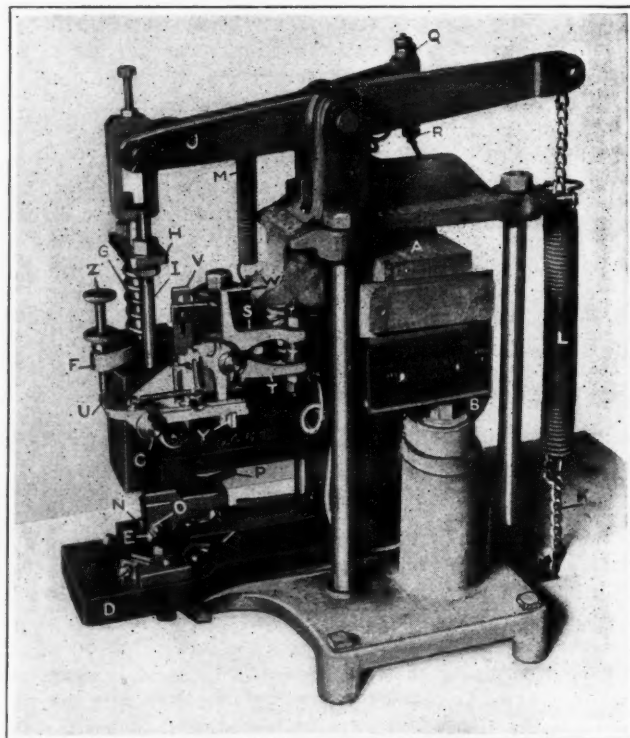


Fig. 11. Special "Thomson" Electric Welding Machine built for welding Platinum Tips to Screws, etc.

ing the burr-removing mechanism is then pressed downward, raising the anvil *J* into engagement with the upset portion of the link, and at the same time operating the upper hammer *K* that strikes one or more blows upon the still heated blank. Meanwhile the pressure on the holding dies is gradually released to permit the chain link to lengthen. After welding and drawing the links, lever *R* is returned to the upper position, thus depressing the anvil and raising the hammer, when the link is removed and the same operation repeated until the entire length of chain has been welded.

At *S* in Fig. 9 is shown another method of welding chain links. In this case, the welded portion of the chain link is reinforced by forcing a large amount of metal into the weld and surrounding parts. This is an upset weld as shown at *T* rather than a flash weld as shown at *U*. The cross-sectional area of the link is increased at the welded joint, making the link as strong at the joint as anywhere else along its section.

Hub and Spoke Welding Machine

Another electric welding machine of a special type, particularly adapted to the welding of hubs and spokes for agricultural wheels, is shown in Fig. 10. In this machine two wrought-iron hubs with the spokes inserted before being brought to the machine are welded together. This machine possesses some interesting points in its construction, es-

pecially as regards the relation of the terminals or contact points, which are secured through copper leaves that interlace or lock when the press is in operation. Power for operating this machine is secured through a hydraulic cylinder located at the top of the press, which is operated by the lever shown in front of the machine.

In operation, the upper contact part of the machine is raised, leaving sufficient space so that the assembled hubs and spokes can be placed in the lower contact die. Then the lever at the front of the machine is operated and the hydraulic pressure forces the upper die down in contact with the work, and at the same time brings the copper leaves into contact with each other. The circuit is then closed and the hubs and spokes that are in contact immediately commence to heat up. In about thirty seconds they reach a welding heat, when the pressure cylinder is again operated and the spokes and hubs are mashed together in one homogeneous mass. The wheel is then taken out and the outer rim placed on it. The hub shown in this illustration is about 4 inches outside diameter and $1\frac{1}{4}$ inch thick, and the spokes are about $\frac{5}{8}$ inch oval shaped.

Special Vertical Butt-Welding Machine

A special bench butt-welding machine of the vertical type for welding platinum tips to screws, etc., is shown in Fig. 11. In this machine, which is built by the Thomson Electric Welding Co., the welding electrodes or clamping dies are disposed vertically instead of horizontally as is the usual construction in butt-welding machines. This machine comprises a core A and secondary casting B. C and D, respectively, are the upper and lower terminals of the secondary casting. The lower terminal carries the anvil-like electrode E on which the disk of platinum is placed, this being retained in a holder which is adjusted by the screws shown.

The upper terminal of the secondary casting carries a slide F, kept down by spring G working against plate H, through which the slide-operating rod I passes. Rod I is raised by rocker lever J which is actuated by chain K attached to a foot-treadle on the floor. This is so arranged that when it is pressed down the chain is pulled down, causing the forward end of the rocker lever to rise and lift slide F. Spring L is interposed to take care of the weight of the chain and treadle so that they will have no effect on lever J, whereas spring M is intended to keep the forward end of lever J down.

Attached to the lower end of slide F is a clamp N consisting of a horizontal rocking lever, to the forward end of which one of the clamping jaws is attached. Facing this jaw is another that is attached to the extreme bottom of the slide by a nut O. These jaws are bored out to suit the diameter of the screw to which the platinum disk is to be welded. The horizontal moving lever is clamped by a cam on which P is the operating handle.

The switch-operating mechanism comprises upper contact arm Q pivoted on the same pin as lever J, but operated independently. R is the lower contact of the switch and is attached to lever J, whereas S and T are, respectively, the upper and lower contact levers of the break-switch. This break-switch is operated through the lever mechanism shown by the screw in slide F that comes in contact with lever U to trip the mechanism.

In operation, slide F is raised slightly to allow the screw to be inserted, which is clamped by operating lever P. The platinum disk is then laid in a slight depression in electrode E. Slide F is now lifted far enough to cause the block on arm V to strike block W, depressing contact lever S sufficiently to bring the contacts on the ends of levers S and T together, and at the same time causing the plate on projecting arm Y to catch on the plate on the end of lever U. The slide is now lowered by raising the foot from the treadle; this brings the screw in the clamping jaws in contact with the platinum disk. Upon further raising of the treadle, the forward end of lever J tips down under the pull of spring M. The closing switch attached to lever J is thus raised, closing the circuit, when fusion between the screw and disk immediately takes place. As fusion progresses there is a slight upsetting of the material due to the pressure of the spring, so

that slide F moves downward an amount equal to the upset. Tripping screw Z now strikes lever U, causing it to be disengaged from the plate on arm Y of lever S. This allows lever S to fly up and thus break the circuit. The weld is now complete, and cam lever P is pushed back to release the screw, whereupon another screw and disk is inserted and the operations are repeated.

The preceding gives some idea of the many types of electric-welding machines built, and shows some of the possibilities of electric welding. Some machines are built to operate semi-automatically, whereas others are built so that it is only necessary to place the work in the machine. Various arrangements are also used for operating the movable head and other movable members of the machine, depending on the requirements. On the smaller sizes the movable head is operated by a lever, by hand or power, and on the larger machines hydraulic pressure is used. The construction and operation of the machine depends largely, of course, upon the shape and nature of the work to be welded. Space will not permit of an extended treatment of these machines, but the underlying principles in all are practically the same.

* * *

CONVENTION OF NATIONAL ASSOCIATION OF CORPORATION SCHOOLS

The third annual convention of the National Association of Corporation Schools will be held at the Hotel Bancroft, Worcester, Mass., June 7 to 11 inclusive. The convention is held in Worcester this year as the result of an invitation tendered at last year's convention by three of Worcester's leading industrial concerns—the Norton Co., the Norton Grinding Co. and the American Steel & Wire Co. George I. Alden, president of the Norton companies, will open the convention with an address of welcome, following which Mayor George M. Wright will extend the freedom of the city to the visitors.

No business will be transacted on Monday, and the first session will be on Tuesday beginning at 9 o'clock and continuing throughout the day, with a round-table talk at night. On Wednesday morning the second session will be held in the ball-room of the Bancroft Hotel, opening at 9 o'clock, and at 4:30 the delegates will leave by special cars for the plant of the Norton Co. for the remainder of the afternoon session. A supper will be served at 6 and the night session concluded in the assembly hall of the Norton plant. An all-day session will be held on Thursday at the Bancroft, and the day will wind up with a big annual banquet in the Bancroft ball-room. The closing session of the convention will be held on Friday morning and will conclude with the annual business meeting and election of officers. Howard W. Dunbar of the Norton Grinding Co., who was appointed general chairman by the executive committee of the association, has selected a number of committees to assist him in preparing for the delegates.

The National Association of Corporation Schools was founded January 24, 1913, and its first meeting was held in the New York University, New York City. The functions of the association were designated as follows: to develop the efficiency of the individual employee; to increase efficiency in industry; and to influence courses of established educational institutions more favorably toward industry. The first annual convention of the association was held at Dayton, Ohio, September 16, 1913, and the second annual convention at the home of the Curtis Publishing Co. in Philadelphia, Pa. Every effort is being put forth to make the third convention profitable to all the delegates attending it, and to give the impetus needed to make its work effective. It has been asserted that if the workers of American industry would increase their efficiency to an average of 10 per cent, in one year the United States would be the leading industrial nation of the world. Prominent men generally realize the crying need of industrial and vocational training, as is evidenced by the statement of President Wilson who in one of his speeches said: "We need trained and disciplined men who know and who can think, men whose judgments are steadied by knowledge."

DOING LATHE WORK ON ALL-GEARED GANG DRILLS

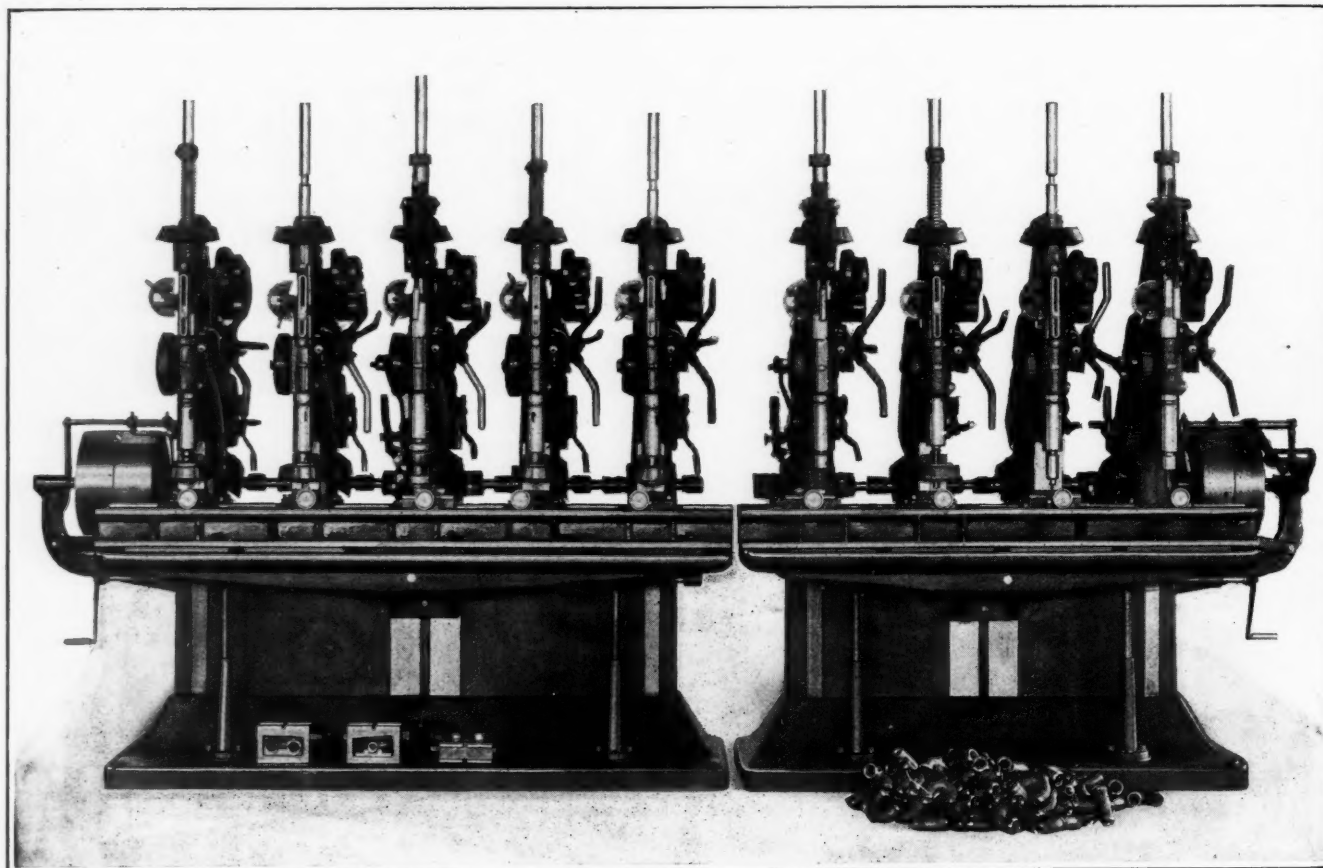
STANDARD DRILLING MACHINES EQUIPPED WITH SPECIAL TOOLS AND FIXTURES
FOR HANDLING UNUSUAL WORK

Fig. 1. Barnes Drill Co.'s Five-spindle and Four-spindle 20-inch All-geared Drills set up as a Battery and equipped for machining Brass U-fittings

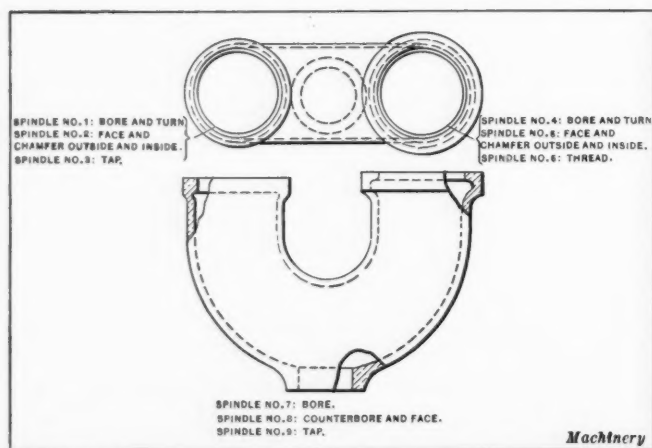


Fig. 2. Operations performed on Brass U-fittings to be machined

THE factory superintendent who is responsible for the maintenance of rates of production is sometimes likely to adhere too closely to traditional methods of machining. This is particularly true in cases where the superintendent has been employed in the same shop for a number of years and has failed to keep abreast of the times. It goes without saying that there are certain operations which can be handled most advantageously on milling machines, others which naturally come within the province of lathe work, etc.; but there are many classes of work that lie on the border line, and that at first sight may appear to come under a given classification, although a careful study of the subject would show that machining the work by some other method would enable a far more satisfactory rate of production to be attained. It is the purpose of this article to describe the way in which the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., has equipped the all-geared multiple spindle drills

of its manufacture for handling several classes of work that would, at first sight, appear to be typical lathe operations. By equipping multiple spindle drills with suitable fixtures, however, it was found that the work could be handled more expeditiously than would have been possible on a lathe.

Fig. 1 shows a five-spindle and a four-spindle drill set up to form a nine-spindle battery for machining brass sanitary U-fittings. The four-spindle machine is built with left-hand drive, in order that its table may come up close to the table of the five-spindle machine. It will be seen that a track is provided on each of the drilling machine tables, and the fixture in which the work is held runs on this track, traveling from spindle to spindle. There are nine operations to be performed on these fittings. In the first six operations, the two

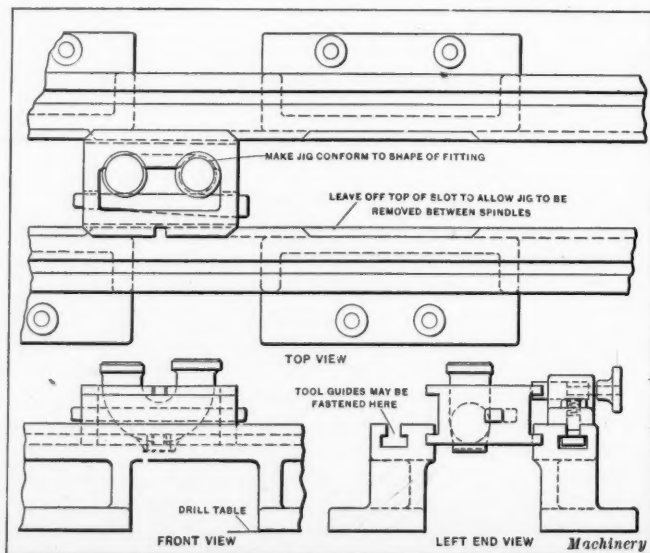


Fig. 3. Section of Fixture used on Machines shown in Fig. 1

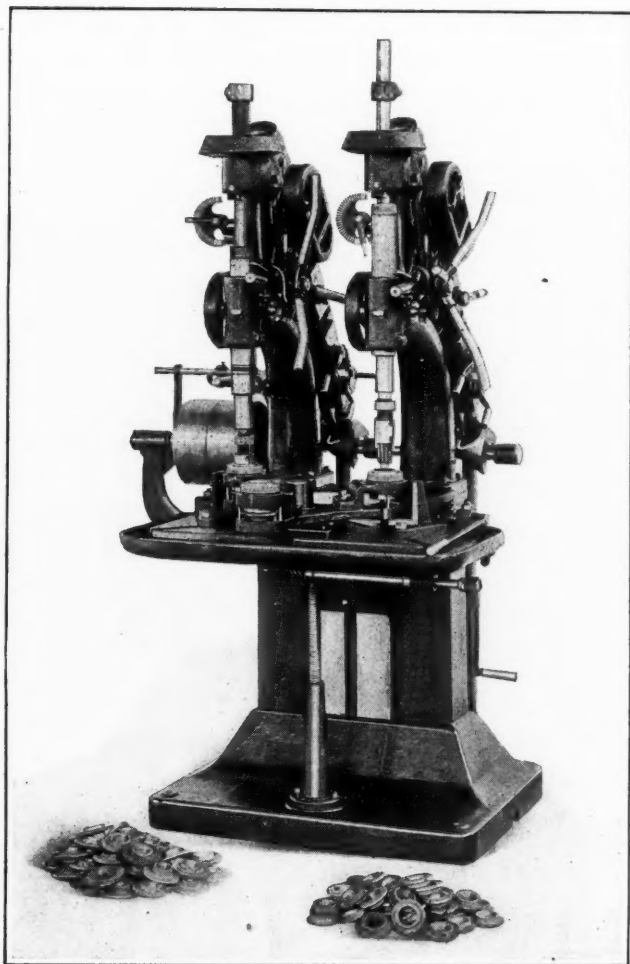


Fig. 4. Barnes Drill Co.'s Two-spindle 20-inch All-gear Drilled equipped with Rotary Fixture

openings in the top of the fitting are machined; and after this, the fixture is turned over on the track to bring the bottom of the fitting into position to be machined. The fixture is then moved along under the remaining three spindles, which machine the bottom of the fitting. This will readily be understood by referring to Fig. 1, where three of the fixtures are shown lying at the base of the machine. Fig. 3 shows a detailed view of a section of the fixture, and Fig. 6 shows the tools used for the turning, boring, chamfering and facing

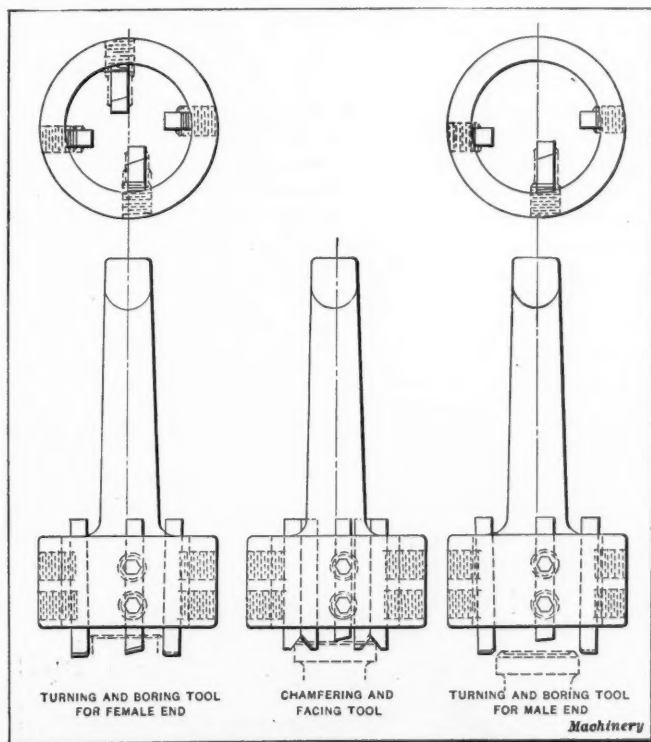


Fig. 6. Tools used for turning, boring, chamfering and facing U-fittings

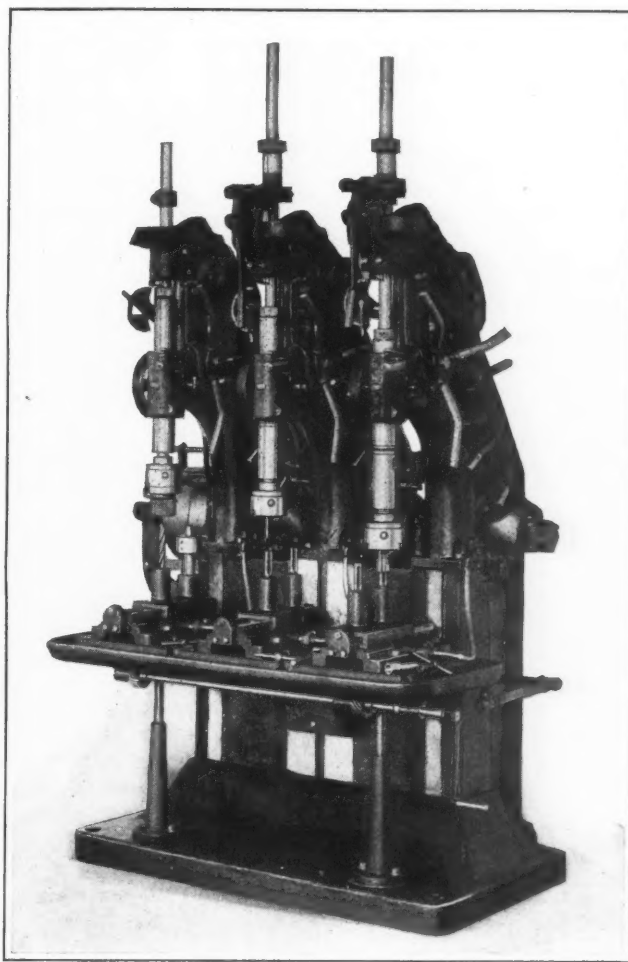


Fig. 5. Barnes Drill Co.'s Three-spindle All-gear Drilled equipped for drilling, facing and tapping Steel Plugs

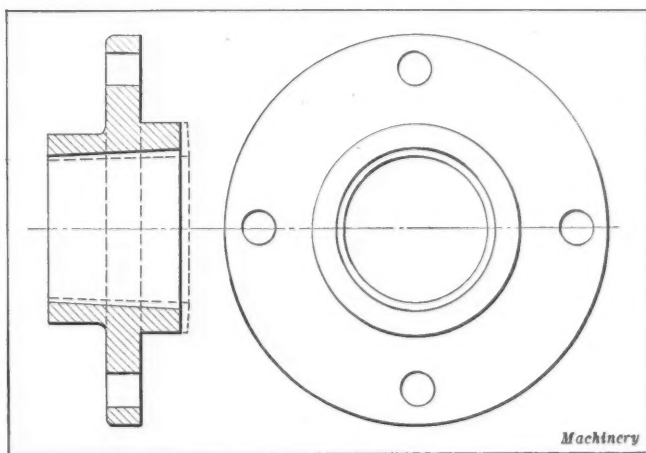


Fig. 7. Work handled on Machine shown in Fig. 4

operations which are performed on these fittings.

Spindle 1 bores and turns the top of the left leg of the fitting; spindle 2 faces and chamfers the outside and inside of the fitting; and spindle 3 performs the tapping operation. Spindle 4 bores and turns the top of the right leg; spindle 5 faces and chamfers the outside and inside of the fitting; and spindle 6 performs the threading operation. After the sixth spindle has finished its work, the fixture is turned over to bring the bottom of the fitting into position to be machined. After this has been done, the fixture is again moved along to the seventh spindle, which bores the opening; spindle 8 counterbores the opening and faces off the bottom of the fitting; and spindle 9 performs the tapping operation. The tapping spindles are provided with positive leaders to insure obtaining perfect threads. One of the threads in the fitting is 27 pitch, which is so fine that without the leader it would be impossible to prevent stripping the threads. By means of this outfit, three men can turn out one finished piece a minute, and the operators need not be skilled mechanics, deftness and agility being the chief requirements.

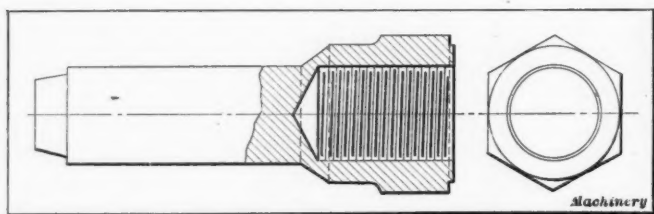


Fig. 8. Work handled on Machine shown in Fig. 5

Fig. 4 shows a Barnes Drill Co.'s two-spindle drill equipped with a rotating fixture and tools for performing the boring, reaming and facing operations on small castings of the form shown in Fig. 7. It will be seen that the work has a tapered hole which must be reamed, and the right-hand edge of the hub has to be faced. The fixture for handling this work revolves on a trunnion fastened to the table of the drilling machine, and consists of a three-armed spider, made with a distance of fifteen inches between work-holders to conform with the standard distance between the spindle centers. The operator unloads the finished work and replaces it with fresh blanks at the front position, during which time the first spindle is performing the rough-boring and facing operation. The fixture is then rotated to bring the partially finished work under the second spindle, where the taper hole is reamed and the edge of the hub faced to exactly the required dimensions, a stop collar being provided at the top of the spindle for this purpose. It will be seen that the first spindle is provided with a spring which automatically returns the spindle as soon as the feed is tripped. With this equipment, a practically continuous operation is secured and the work can be done by an unskilled operator.

Fig. 5 shows a Barnes Drill Co.'s three-spindle, all-gear drill equipped with fixtures and tools for drilling, facing and tapping steel parts of the form shown in Fig. 8. The work is

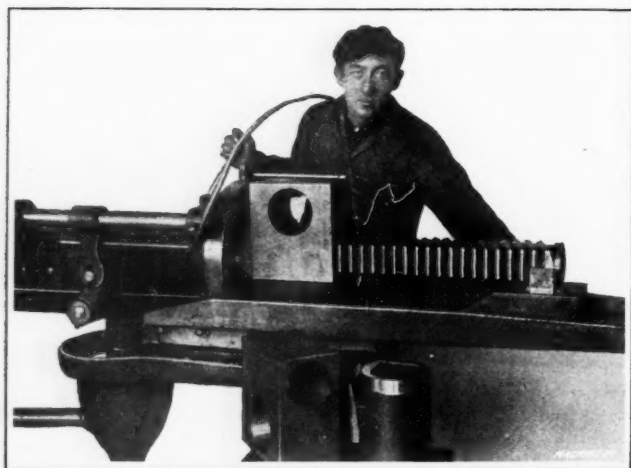


Fig. 1. Broaching a 4-inch Square Hole

held in a chuck in the drill spindle and the first operation consists of drilling the hole with the work held in the left-hand spindle of the machine. After this has been done, the fixture on which the tools are carried is moved forward to bring the facing tool into position to face off the end of the work. The spindle is equipped with a stop collar to provide for drilling and facing the work to the required depth. After these operations have been completed, the work is transferred to the second or third spindle, where it is rough-tapped by the first tap carried on the fixture, after which the fixture is moved forward to bring the finishing tap into position to have the work fed down onto it. The two tapping spindles are provided with positive leaders to insure obtaining perfect threads, and the taps have holes through the center to provide for delivering oil into the work. The drilling and facing operations can be performed more rapidly than the tapping operations; hence, the provision of two tapping spindles to handle work that is drilled and faced by a single spindle. These are typical examples of a great many jobs formerly done on the lathe for which the Barnes Drill Co. has fitted up gang drills. In these cases a very satisfactory rate of production has been obtained.

E. K. H.

BROACHING A LARGE SQUARE HOLE

An interesting broaching operation on a gun carriage part is illustrated in Fig. 1. This piece is a hard steel block and the broached hole is 9 inches long and 4 inches square, finished as indicated by the view to the left in Fig. 2. The rough-bored hole is squared by the use of five broaches which follow one another in the usual manner; that is, the corners are partially cut away by the first broach and the neck of the second broach is made to enter the hole left by the preceding one, and so on, until the hole is finished to the required shape. Owing to the length of the hole, the broach teeth were spaced $1\frac{1}{4}$ inch apart in order to provide sufficient chip room.

Each broach removes over $1\frac{1}{2}$ pound of chips and the total weight of the chips from each hole is about $7\frac{1}{2}$ or 8 pounds.

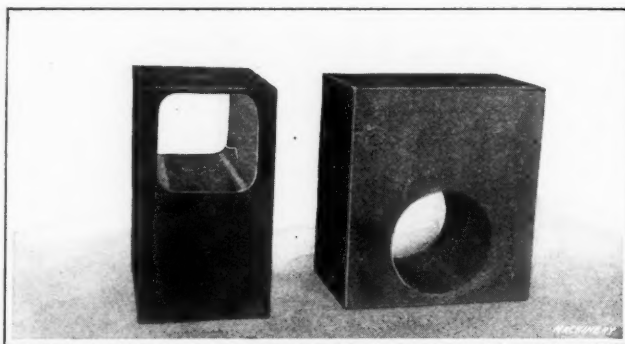


Fig. 2. Gun Carriage Part broached as illustrated in Fig. 1

Fig. 3 shows a pile of chips removed from one of these holes and also one of the pieces used for testing the broaches. The last broach removes about $1/32$ inch of metal all around, and very accurate work is obtained notwithstanding its size. The walls at the side of the hole are only $\frac{1}{2}$ inch thick, and at one end the thickness is only $\frac{1}{4}$ inch. The time required for this operation is approximately twenty minutes, although the rate of production naturally depends somewhat upon the activity of the operator.

As Fig. 1 shows, the machine is equipped with a long supporting table and the outer end of the broach rests upon a sliding carriage. Each broach weighs 235 pounds. This machine and the broaches used for the operation referred to were made by the J. N. Lapointe Co., New London, Conn. According to the experience of this company, built-up broaches for such large and heavy work are not sufficiently strong and only solid broaches are used. These are said to be capable of broaching from 4000 to 5000 pieces without being worn enough to cause any appreciable change in the size of the hole.

* * *

The laws of science are being recognized and applied in the daily lives of the people today as never before. Rapid strides are being made in the manufacturing, transportation, communication, structural, commercial, agricultural and industrial interests of the world. To keep pace with this advancement the world workers must be trained. No longer is the finger of scorn pointed at the theorist, the scientist and the applied scientist in the world's workshop. Science goes hand in hand with practice.—R. B. Dale in "The Iowa Engineer."

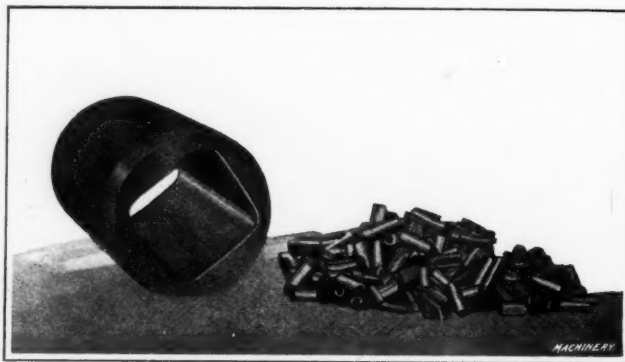


Fig. 3. Chips removed by Each Broach and Piece used for testing Broaches

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

THE SETTING OF ANGLE GAGES

In the December number of MACHINERY, John Mahon describes a useful form of gage for measuring tapered plugs, but a brief consideration makes it evident that his setting gage is only designed for very small tapers. This, of course, is due to having the center distance between the holes in which the setting disks are held fixed, this distance being only 3 inches. Doubtless Mr. Mahon's gage was designed for work with very small tapers, but if it is to be in any sense universal, it would be much better to have the setting gage provided with means for adjusting the center distance between the disks.

The rule for determining the center distance between the setting disks of an angle gage is as follows: The distance between centers must be equal to the difference in the radii of the disks divided by the sine of one-half the taper angle. Calling the distance between centers L , the difference in the

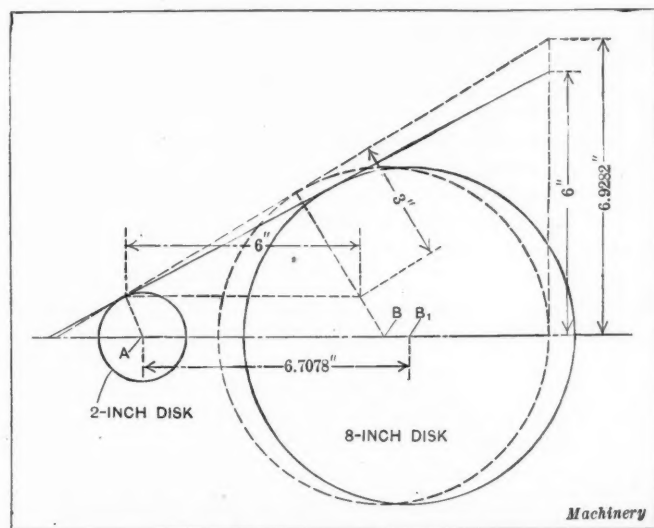


Diagram illustrating Desirability of having Center Distance between Disks Adjustable

radii of the setting disks $R - r$ and the whole taper angle α , we have:

$$L = \frac{R - r}{\sin \frac{1}{2} \alpha}$$

The following discussion of the method of setting angle gages may prove of interest and value, and it applies with equal force to the universal angle gage which I described on page 315 of the December number of MACHINERY, as well as to Mr. Mahon's gage previously referred to. In all calculations of this kind we deal with one-half the taper angle, dividing it on the center line. Suppose it is attempted to make a setting for the taper shown by the full line for one-half the taper angle, using setting disks 2 and 8 inches in diameter, respectively. Here the difference in radii $R - r$ is 3 inches. Referring to the accompanying illustration, it will be seen that the 8-inch disk cannot be used in this case as it is too large to enable the required angle to be obtained with a center distance of 6 inches. The center of the 8-inch disk would have to be at B_1 , making the distance between the centers of the disks 6.7078 inches. Using the disks with 6 inches between centers would produce the taper of 3 inches in 6 inches for one-half the taper angle, as shown by dotted lines.

To illustrate the use of the rule for determining the distance L between the centers of the setting disks, the following examples are given: Suppose it is required to set for an included taper angle of 60 degrees, using disks 1 inch and 5 inches in diameter, respectively. One-half the taper angle is 30 degrees and the sine of 30 degrees is 0.5. The difference in the radii of the disks is 2 inches.

$$L = \frac{R - r}{\sin \frac{1}{2} \alpha} = \frac{2}{0.5} = 4 \text{ inches.}$$

As a further example, suppose it is required to set for a taper of $\frac{3}{4}$ inch per foot, using disks 1 inch and $1\frac{1}{2}$ inch in diameter, respectively. One-half the taper angle will obviously be 0.375 inch per foot and

$$\frac{0.375}{12} = \tan \frac{1}{2} \alpha = 0.03125.$$

$$\frac{1}{2} \alpha = 1 \text{ degree } 47 \text{ minutes}$$

$$\sin \frac{1}{2} \alpha = 0.03112.$$

$$L = \frac{R - r}{\sin \frac{1}{2} \alpha} = \frac{0.25}{0.03112} = 8.0334 \text{ inches.}$$

A good way to set the disks at the required distance between centers is to measure over their outside with a micrometer set to the required center distance, plus the sum of the disk radii. With a holder that permits of adjusting the center distance between the disks, it will rarely be necessary to make new disks in order to obtain any required setting.

Turtle Creek, Pa.

WILLIAM S. ROWELL

HOLLOW STEEL BEARING BALLS

The writer, who is much interested in the design of ball bearings for machinery, has been struck with the evident waste of high-grade material in large steel balls when the diameters are, say, one inch and over. Not only is an amount of valuable steel wasted, but it is worse than wasted. Large bearing balls weigh pounds when they should weigh ounces, and the heavy, useless weight is a serious disadvantage at high speeds, the inertia of the balls causing them to hammer the races and ruin them when speeds become excessive.

Being somewhat familiar with the possibilities of electrical welding, I suggest that the manufacturers of steel balls consider the feasibility of making hollow steel balls for all the larger sizes. This, I believe, could be readily accomplished by forging the balls in hollow hemispherical parts and joining them by electric welding. After being electrically welded, the hollow steel ball would be heated, hardened, tempered, rough-ground, finish-ground, polished, inspected and, in short, treated the same as a high-grade ball made from a solid forging. The advantages of the hollow ball would be a saving of material, greater elasticity, more uniform hardness, freedom from internal stresses and reduced weight.

I recommend that all steel balls one-half inch diameter and larger be made hollow, the thickness of the wall relative to the diameter decreasing progressively with increase of diameter. To illustrate, the thickness of shell of a hollow one-inch diameter ball might be, say, one-eighth inch, while the thickness of a three-inch ball shell would be, say, only one-quarter inch. The weight of a hollow one-inch ball with a one-eighth inch shell is about 0.084 pound, and that of a three-inch hollow ball with one-quarter-inch shell is about 1.654 pound, while the weights of solid one-inch and three-inch balls are 0.145 pound and 3.927 pounds, respectively.

M. E. CANEK

The foregoing contribution was submitted to L. J. Hoover, vice-president and general manager of the Hoover Steel Ball Co., Ann Arbor, Mich., who comments as follows:

A few years ago the writer spent several thousand dollars for a concern with whom he was connected in making hollow steel billiard balls. The principal reasons why a hollow steel ball would not be satisfactory are as follows:

1. You cannot get a high-grade material that will draw into a half sphere without cracking. If it is annealed soft enough so that it will not crack, the steel has been so decarbonized that it will not harden properly.

2. The expense of the dies alone would be tremendous, as you would have to have three sizes of dies for every size of ball, and would have to anneal the metal for every time you draw the half sphere, as the bending of the metal would crystallize it considerably, which can only be relieved by an-

nealing. This could only be bent a small distance each time; therefore it would be absolutely necessary to have three separate sizes of dies.

3. With electrical welding you would throw up a fin on the inside of the ball which you could not remove, as by putting the two parts together to make the complete sphere you have to press the metal when it is red-hot, which throws inward a little fin that will not allow the ball to balance. Of course the outside fin could be removed by grinding, but the inside would gradually rattle off and you would have a rattle box which would be very nice for some child to play with.

4. Any metal that is electrically welded cannot be hardened where it has been welded; therefore you would have a soft streak all the way around the ball when it is tempered, as the electric welding process takes out all the carbon where the electric juice is turned on and the steel brought up to the welding point.

5. After you had completed the ball, you would have nothing left but an egg-shell, which would be hard on two sides with a soft streak around where the electric welding process took effect, as it would have to be made from very cheap material to be drawn cold and you would have a very hard shell just the same as an egg-shell; but just as soon as you put any weight on the ball it would crush into so many pieces that you could not put them together. In drawing these half circles, you could not draw them evenly and the ball would be thicker in some places than in others; therefore the expansion and contraction would not be the same and you could not grind these to a perfect sphere.

The cost of the manufacturing of these hollow balls would be several times in advance of the cost of manufacturing the solid steel balls. There would be no resistance in the hollow ball whatever, as on a large sized ball it is the soft metal in the heart of the ball which gives it the resistance, as a three-inch ball will only harden about one-quarter inch deep, being backed up with the soft metal of the heart.

MAKING A RIBBED DIE

To produce the type of die shown in the accompanying illustration in an economical way, is a problem that might

puzzle many mechanics; but the method of casting this piece of work, as described and illustrated herewith, is inexpensive and will prove very successful, provided a few important points are observed. A brass cone is turned and used as a core, with the angle the same as the inside of the brass die to be made. Slots are milled around the cone surface, the depth and angle being made the same as the

required position of the ribs in the die. These slots are made just wide enough to permit the ribs to be set in close without driving. Before inserting the ribs, however, the outside of the core is coated with a solution of lamp black and turpentine, applied with a small brush for the purpose of preventing the molten brass from sticking to the core. The slots are cleaned by drawing a piece of flat thin steel through them, which removes any fine chips that may be lying in the bottom. Care must be taken when inserting the ribs, to have both ends down in the bottom of the slots. If the ribs, by being loose, are likely to move or shift in the slots, the sides of the slots should be peened just sufficiently to hold the ribs in place, as shown in an exaggerated manner at A.

The core is then ready to be set in the mold, and the die is cast. It will be seen that by making the mold as shown, both centers of the core are available for use. The die is taken directly from the sand mold and placed in the lathe, using the core as a mandrel. After finishing the outside, the core is driven out and the inside finished by filing. It must be remembered that the core should be well coated with the lamp black and turpentine solution, and that the brass should not be poured at too intense a heat, which would cause the

surface of the core to melt in spots, making it almost impossible to drive out. But it is not necessary to have the core heated when pouring. This type of die was used in forming flexible material, and extreme accuracy of the product was not required.

Moore, Pa.

JOHN LEAFSTROM

EQUIPMENT FOR TRADE SCHOOLS

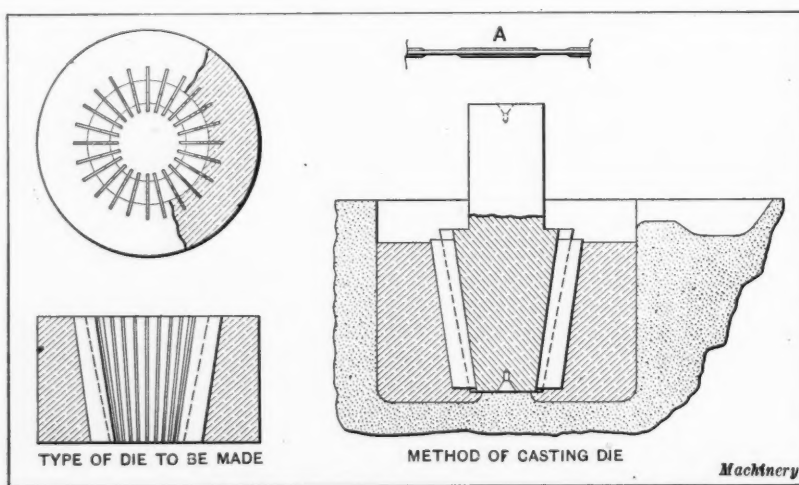
Every little while, and especially when general business is a little dull, some one brings out a new machine adapted, in his mind, to some educational use. Manual training and technical schools, and more recently trade schools, are a Mecca to the man who wants to get business, for they are seldom if ever affected by hard times, their accounts are always good, and occasionally the purchasing agent is not keenly onto his job. On page 333 of the December number of MACHINERY there is illustrated a contraption that is stated to be "particularly intended for use in trade schools where students may become familiar with these types of equipment before starting work on high-class machine tools which might be readily damaged." While I realize, of course, that such a statement is not an editorial endorsement of the device, it is a statement that appearing in conjunction with so many things that are good may make a wrong impression on men whose duties as buyers for trade schools are not based on a knowledge of the machine tool business.

For nearly six years I have had charge of the machine shop section of as large a school as there is in the country, which is strictly a trade school. During that time there has not been over \$100 damage done to the machine tools in the shop, and we have over \$30,000 worth of as good machinery as money can buy. This is less than would have occurred with an equal number of journeymen machinists. The boys

come in, off the street or from grammar school or high school, without any previous notions of machine work; and they are put at work on a lathe or a miller the first hour they are in the place. At first it was our idea that the machines should be protected by automatic stops and that they should be completely set up before the boys came to work, and that an older boy should really be responsible for the job. Now we find that there is little danger the first part

of the time that a boy is in the shop. Later on, after he has become familiar with the place and the machinery, there is more danger that he will become careless and will take unnecessary chances.

There is no reason why a boy should not be trained in this way from the very start, on machinery which is life size and on which he can do work that is a credit to the school, except the fact that such equipment costs heavily. It seems a pity to tie up \$500 or \$600 worth of machinery to try out a boy, when you know beforehand that at least half of those that you try out are not fitted for the machinist's trade but must later be switched to some other industry. It seems as if some one ought to be able to bring out a lathe with every essential part for the production of plain work, that would enable a school to teach a boy the two most essential principles of the machinist trade—to cut metal and to measure. Such a machine need not be back-gear, nor does it need a power cross-feed, a compound rest, nor a large faceplate, and half of them need not be equipped for screw cutting. They need not be heavy, though they should have large cones for wide driving belts. They will seldom be used for turning or boring work over 2 inches in diameter, but they should



Punch and Die, and Method of casting the Die

swing 14 or 16 inches. Such a machine will, of course, cost much more than the combination machine referred to, but it will do real work in quantities, and within its range it will be the equal of the higher priced wider ranged tool.

Worcester, Mass.

JOHN P. CASEY

ORDERING TOOLS AND SUPPLIES IN THE FACTORY

Practically every factory has a different method-of handling requisitions for tools and supplies for the various departments. In many factories there is too much red tape in the ordering of small tools and supplies generally. In fact, there is more red tape in the ordering of the less expensive materials and tools than in the case of the more expensive machines. The reason for this is probably that in a large factory small tools and supplies are ordered by a great number of individuals holding subordinate positions in the organization, while the orders for the larger and more expensive equipment generally come from men of greater responsibility; therefore, it is assumed that a more careful supervision is necessary over the orders for minor tools and supplies than in the case of the orders for larger machines.

Few concerns carry in their tool-room an adequate supply of tools for the needs of their shop force, but depend to a large extent on the fact that many skilled mechanics have a considerable kit of tools of their own. New men added to the force are therefore often handicapped by the lack of suitable tools for the work they are expected to do. Niggardliness in respect to small tools does not pay, however. These should be considered just as vital a part of a modern shop equipment as any of the machine tools.

The difficulty which arises in the ordering of small tools and supplies is to formulate a system by means of which it can easily be determined what should and what should not be ordered. If every requisition is too closely questioned and the system is too rigid, a foreman will hesitate about asking for necessary tools and supplies, because he feels

that his judgment is questioned. Hence, many necessary supplies may be neglected. On the other hand, if every request coming from the foreman was passed without comment, abuse of the privilege would in many cases become a source of unnecessary expense.

The best way to take care of this matter is to let all the requisitions pass through the hands of a properly trained man capable of exercising judgment in the matter of standard supplies and small tools, and who should keep records which would indicate whether the consumption at any one time exceeded the regular consumption of similar supplies, in which case he would investigate the matter and take steps to correct the trouble. When requests are made for articles which are not regularly purchased, then the facts relating to the matter should be ascertained by the person in charge of the purchasing, and he should place these before the chief executive for his decision. In this way, the executive can be relieved of the routine of approving a needless number of regular orders, and yet feel that when any department calls for something that is not part of the regular equipment he will have an opportunity to decide whether or not the expense is warranted.

Sarnia, Ontario, Canada.

P. W. BLAIR

UNIVERSAL KEYSEAT MILLING FIXTURE

The purpose of this fixture is to provide a means of cutting keyways in various sizes of shafts, provision being made for holding four pieces of shafting at one time without the necessity of changing the spacing collars between the cutters. To enable this to be done the shafts must be brought central with the cutters, which is provided for by means of the adjusting gibs A. These gibs are located by pins B fitting into several tapered holes, each hole providing for setting the fixture for a given size of shafting. Reference to the illustration will make it evident that the gibs A act in conjunction with gibs D which grip the work. It will be seen that the gibs D are provided with tongues on their under side, which fit in transverse grooves to provide the necessary adjustment.

After the shafts C are placed in the fixture, they are secured in place by the clamps E which are held down by bolts entering holes G provided at the center of the fixture, as shown in the plan view. This fixture was designed for splining shafts from 4 to 7 feet in length, one of these fixtures being used on each end of the milling machine table. It will be evident that the time consumed in setting the jigs is much less than it would be for changing the spacing collars between the cutters, as the necessity of truing up the cutters after changing the spacing collars is eliminated.

Readville, Mass.

O. A. WEBSTER

SENDING ANNOUNCEMENTS OF CATALOGUES

A few months ago I made a suggestion to my firm that has

produced very good results. At that time I was checking up a list of about 10,000 names of firms and individuals to whom we intended to send catalogues. These catalogues were then in course of preparation and would not be off the press for about another month. It occurred to me that it might be a good plan to send "preparatory letters" or announcements in advance of the catalogue, to every name on the list, stating that

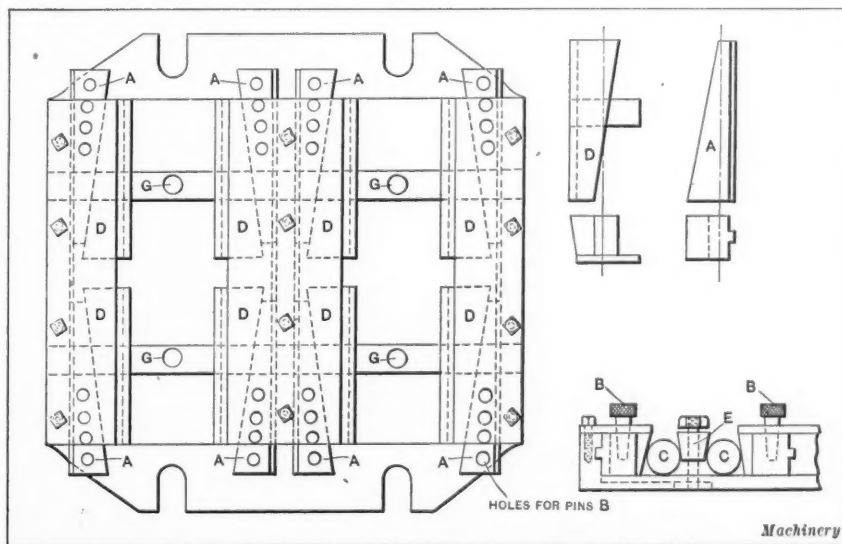
their name had been suggested to us as that of a possible customer, that we were getting out a catalogue which would undoubtedly prove of interest, and that a copy of the catalogue would be mailed as soon as it was off the press.

The firm adopted my suggestion and sent a letter of this character in advance of each catalogue, the letter incorporating a brief outline of what the catalogue would contain. We believe that the use of these letters caused our catalogues to be considered of more value, so that they were not thrown into the wastebasket. People knew that the catalogues were coming and had become slightly interested in them before they arrived. In undertaking a campaign of this character, it pays to spend plenty of time in working up a list. Don't make the mistake of sending catalogues to "dead timber"; also, it certainly ought to pay to spend a little extra money in interesting those to whom you intend to send a catalogue, so that they will give it due consideration when it arrives.

N. G. NEAR

DRAWING A DEEP CUP

The accompanying illustration shows successive steps in the drawing of a deep cup or shell that was used for an automobile rear axle housing. We have made about 150,000 of



Keyseat Milling Fixture with Adjustment to provide for holding Various Sizes of Shafting

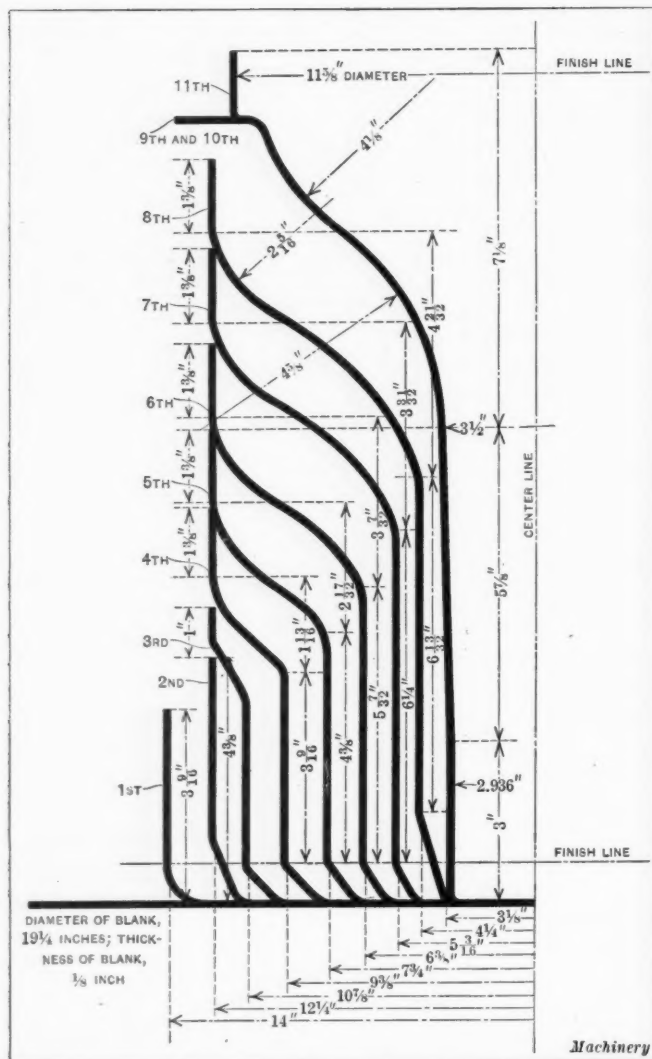


Diagram showing Dimensions at Successive Steps in drawing a Deep Cup

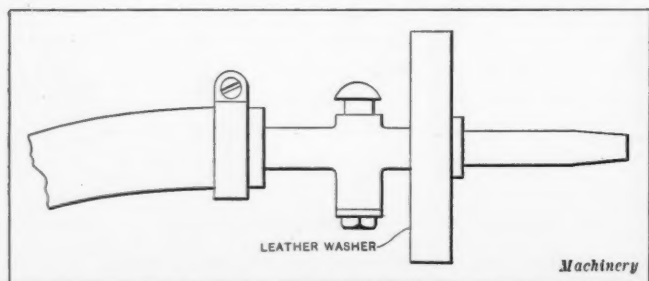
these cups and have obtained very satisfactory results, an average of only three or four cups out of each hundred being broken by pulling out the bottom. It is found necessary to anneal the work three times—after the third, sixth and ninth operations. The punches and dies were made of steel castings which were carbonized and hardened. No blank holders were used on this job. In the ninth operation, the flange was drawn at right angles to the shell, this being done so that the shell could be held for the tenth operation (not shown in the illustration), in which eight pockets are drawn and bolt holes pierced in them. The eleventh operation consisted of turning the flange straight with the body of the shell, and no trouble was experienced in doing this.

Vredenburgh, Ala.

WILLIAM BUTZLAFF

SAFETY COLLAR TO PROTECT AIR VALVES

In a manufacturing plant making extensive use of compressed air, the complaint was made that the self-closing valves with which all hose ends were equipped frequently gave trouble due to leakage and breakage. A study of the conditions under which the valves were used revealed the



Built-up Leather Washer used as a Safety Collar to protect Air Valve

fact that when the workers were through using the air they would drop the hose onto the floor near their work so that it would be convenient when needed. As the floors are of cement construction, this resulted in the valve receiving a hard blow many times a day.

It seemed to be impossible to break the men of this habit of rough handling, partly due to the fact that the noise of the machinery made it impossible for them to realize what a severe blow the valve really received, and also because the piece work system under which these men were working does not tend to encourage workers to expend any thought on matters that do not immediately increase the "upholstering" of their pay envelopes. These valves are made of soft metal and are not very rugged, so it was decided to change the design to meet these severe conditions; and the whole trouble was eliminated by the addition of a safety collar as shown in the illustration.

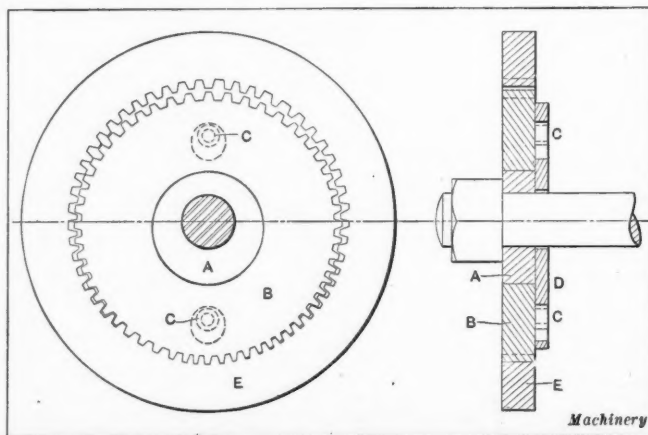
This collar is simply a leather washer about three inches in diameter, built up to a thickness of a half inch and provided with a hole of the proper size to permit it to be slipped onto the nozzle of the valve just in front of the push button. This leather collar is held securely in place by the addition of a metal band that is soldered to the nozzle, and the arrangement leaves the valve easy of manipulation and does not prevent getting the air just where it is needed. It is now impossible for the valve body to touch the floor when the hose is thrown down, so the valve, instead of receiving a dull destructive thud, bounces about like a Halloween apple in a tub of water.

Madison, Wis.

FRANK S. CULVER

SOLUTION OF SPEED REDUCTION

A speed reducing mechanism of an unusual form has been brought to the attention of the writer, and it is thought that perhaps it may be of interest to others. It is of the planetary type, making use of but two gears, as shown in the



Speed Reduction Mechanism used on an Automobile Motor Self Starter

accompanying illustration, and is used on one make of electric starting motor for automobile engines where a great speed reduction between the starting motor and the engine is desired. An eccentric A, carried by the driving shaft of the motor, imparts motion to a gear wheel B which is prevented from turning by two rollers C that slide in slots in a fixed plate D. The oscillatory motion that is transmitted to the gear B imparts a much reduced rotary motion to the driven gear E, the teeth of which mesh with those on B. On the starting motor referred to, the gear B has 54 teeth and the gear E has 56 teeth. The speed reduction is in the ratio of 28 to 1, and this result may be arrived at as follows: Suppose, first, that the three members A, B and E are locked together and turned in a clockwise direction through one revolution. Then, in order to verify the fact that the gear B does not rotate, but has an oscillatory motion, imagine the eccentric A to be held stationary and the gear B turned in a counter-clockwise direction through a revolution, bringing it back to its original position. During this operation, gear E

54

will turn — of a revolution in a counter-clockwise direction.

56

Since it was first turned one revolution in a clockwise direction, it is now $1 - \frac{54}{56} = \frac{2}{56}$ or $\frac{1}{28}$ of a revolution from its original position. In other words, for the one revolution that the eccentric *A* has been turned, the gear *E* has moved ahead $\frac{1}{28}$ of a revolution, and the gear reduction is 1 to $\frac{1}{28}$ or 28 to 1.

Tabulated, the result is as follows:

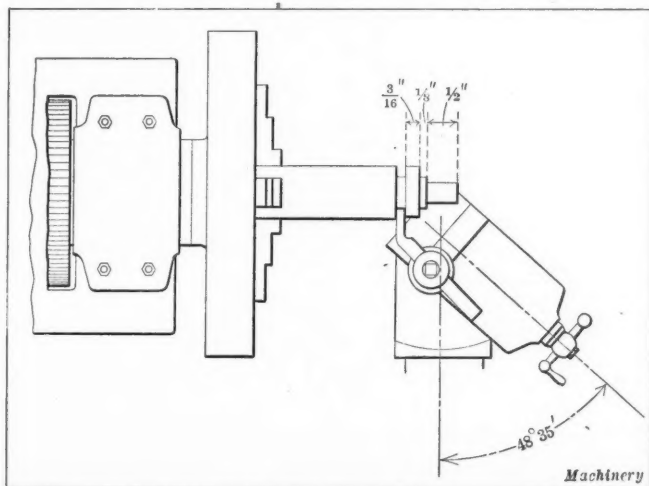
	<i>A</i>	<i>B</i>	<i>E</i>
Gears and eccentric locked....	+1	+1	+1
Eccentric <i>A</i> stationary.....	0	-1	- $\frac{54}{56}$
	+1	0	$+\frac{2}{56}$ or $+\frac{1}{28}$

That is, speed of *A* : speed of *E* :: 1 : $\frac{1}{28}$, or as 28 : 1.

Therefore in order to move gear *E* through one revolution, it is necessary to give the eccentric *A* 28 turns. S. H. Y.

COMPOUND REST KINKS

The writer recently saw a lathe operator using his compound rest in an ingenious way. The lathe was a very old machine which did not have a graduated collar on the compound rest screw. The slide was kept set 30 degrees off center for convenience in thread cutting, and when facing operations were being performed it was fed up twice as far as the depth of the facing cut it was desired to take. A brief consideration will make the reason for this evident when it is borne in mind that the sine of 30 degrees is 0.5000. The same workman, when using a lathe with a compound rest



Setting of Compound Rest with 6-pitch Screw, to facilitate machining Work dimensioned with Common Fractions

screw having six threads per inch, makes a practice of setting the slide at 48 degrees 35 minutes off center when he has to make a number of small pieces with lengths given in common fractions of an inch, as shown in the illustration. With the slide set in this way, a whole turn of the screw corresponds to $\frac{1}{8}$ inch, a half turn to $\frac{1}{16}$ inch, and a quarter turn to $\frac{1}{32}$ inch travel of the tool in a line parallel with the axis of the work. The sine of 48 degrees 35 minutes is 0.7499, and as previously stated the pitch of the compound rest screw is $\frac{1}{6}$ inch. Then for one complete turn of the handle, the tool is advanced parallel to the axis of the work a distance equal to $0.7499 \times \frac{1}{6}$ equals $\frac{1}{8}$ inch; and movements of $\frac{1}{16}$ and $\frac{1}{32}$ inch are obtained by half and quarter turns of the handle, respectively.

The writer believes that compound rest screws with six threads per inch are an abomination, as it complicates machining work where common fractions are used to specify the dimensions. By having the pitch of the screw equal to a common fraction, as $\frac{1}{8}$ inch, the movement of the tool is much more easily regulated. Of course a graduated collar on the compound rest screw would save all this trouble.

Turtle Creek, Pa.

WILLIAM S. ROWELL

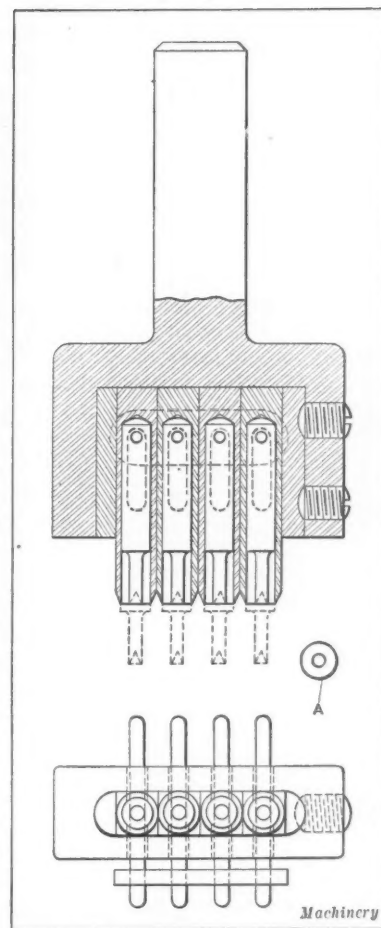
MULTIPLE HAND PUNCH

The multiple hand punch illustrated and described herewith has given very satisfactory results in producing small leather washers of the form shown at *A*. These washers are cut from $\frac{1}{32}$ -inch stock, and it will be noted that the design of the punch provides for cutting the washer from the stock and punching the hole at the same time. The punches which cut out the washer are made square on the outside and held tightly in place by an arrangement of clamping strips and set-screws, which is clearly illustrated. These punches are bored on the inside to the required diameter of the washer which is to be made and the outside is taper-turned to form the cutting edge.

The piercing punches are made a sliding fit in the outside punches and the working section of the punches is made long enough to allow a considerable number of washers to accumulate before it is necessary to remove them. It will be seen that each of the piercing punches is fitted with a cross pin, these pins, in turn, being connected by a small bar. By connecting the pins in this way, the punches may be shifted out together—as shown by the dotted lines—to provide for removing the finished washers. About fifteen washers can be run up onto each of the punches so that a total of sixty washers can be made before requiring the piercing punches to be run down to strip the washers from them.

As originally made, the piercing punches had a 60-degree included angle. This caused considerable trouble, because of the fact that the punching from the hole in the washer wedged into the center of the punch, making it impossible to stamp out a second washer until this waste had been removed. However, when new inside punches with a 45-degree included angle were made, as shown in the illustration, the difficulty was entirely overcome, as the punchings remained in the end grain of the hard maplewood slab which was used as a stamping block. The inside punches only were hardened. Moore, Pa.

JOHN LEAFSTROM



Multiple Hand Punch for stamping Leather Washers

SIMULTANEOUS INTERNAL AND EXTERNAL FORMING ON SCREW MACHINE

The accompanying illustrations show the method of procedure in manufacturing ball bearing races, in which the in-

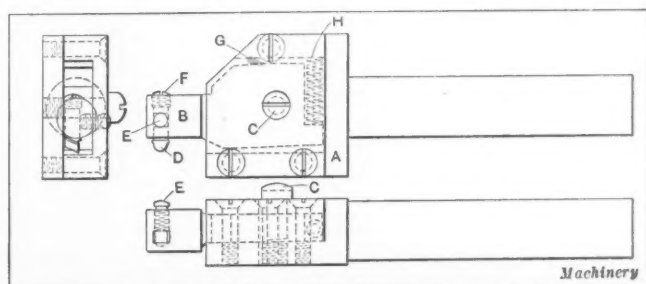


Fig. 1. Internal Forming Tool carried in Turret of Screw Machine

ternal and external forming operations are performed simultaneously. The requirement of accuracy on this work is 0.002 inch either way from the specified size, and it is required to finish the ball grooves smooth enough so that grinding will not be necessary after the casehardening operation has been performed. The material is carbon steel containing 0.20 per cent of carbon.

The usual method of centering, drilling and reaming with turret tools is employed, after which the internal grooving tool shown in Fig. 1 is brought into position and entered into the hole previously drilled in the race. This tool consists of the body A with a shank to fit the turret hole. The swinging arm B is carried by the body of the tool, this arm being pivoted on the screw C. A high-speed steel internal forming tool D is carried in the swinging arm and held in place by the screw E, the tool D being backed up by the headless set-screw F. The arm B is normally held in contact with the surface G by means of a coil spring H.

The external forming tool J, shown in Fig. 2, is carried in the rear toolpost or angle-block K, in which the screw L is inserted. The position of the screw L is fixed by a check-nut. When the internal forming tool is in place, the cross-slide of the machine is brought forward and the screw L engages with and forces the internal forming tool forward, thus

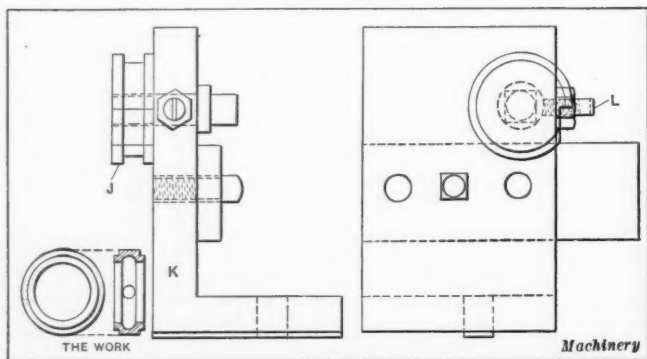


Fig. 2. Work and External Forming Tool carried in Rear Toolpost

cutting the ball race simultaneously with the external forming operation. Owing to the length of the internal tool, a support is provided from the rear toolpost to steady this tool and prevent chatter and vibration. In doing this work, a hand-operated screw machine with power feed of the turret slide was employed; and the results obtained were very satisfactory for producing these pieces in relatively small quantities.

Aurora, Ill.

CORWIN LAMOREAUX

OLD PISTON USED FOR A CORE BOX

After re boring the cylinder of a gasoline engine, the mechanic is often required to make a pattern and core box for use in casting a new over-size piston to fit the enlarged cylinder. An inexpensive core box for use in this connection may be quickly made by splitting the old piston through the center, at right angles to the axis of the wrist-pin bosses, as shown in Fig. 1. These two halves of the old piston are held together by a wooden block, as shown in Fig. 2, and the

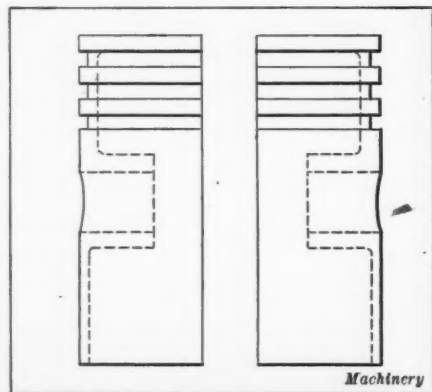


Fig. 1. Old Piston split ready for Use as a Core Box in casting New Piston

inside of the old piston is then employed in molding a core for use in casting a new piston. The block of wood in which the halves of the old piston are held should be thick enough to allow sufficient length for the core print to extend beyond the piston, as shown in Fig. 2, and if desired the block may

be cylindrical in shape.

Fig. 3 shows this block in detail, and this illustration is to be referred to in connection with the following description of the making of the block. The large hole is bored to such a size that the old piston fits tightly in it before being split, and the smaller hole is bored to the same size as the inside diameter of the open end of the piston. It will be

evident to the reader that this smaller hole forms the core print, and so it should be slightly tapered so that the block may be easily withdrawn after the core has been rammed up in the box. The block is first withdrawn and then the two halves of the old piston are separated and removed from the core which is now ready for any finishing touches that it may require; for instance, the necessary correction to allow sufficient metal for machining on the inside faces of the wrist-pin bosses. This adjustment of the core should be made before it is baked. In some cases it may be desired to cast solid

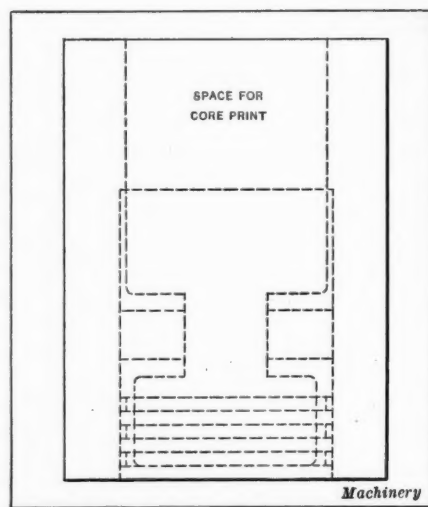


Fig. 2. Split Piston held in a Wooden Block ready for making the Core

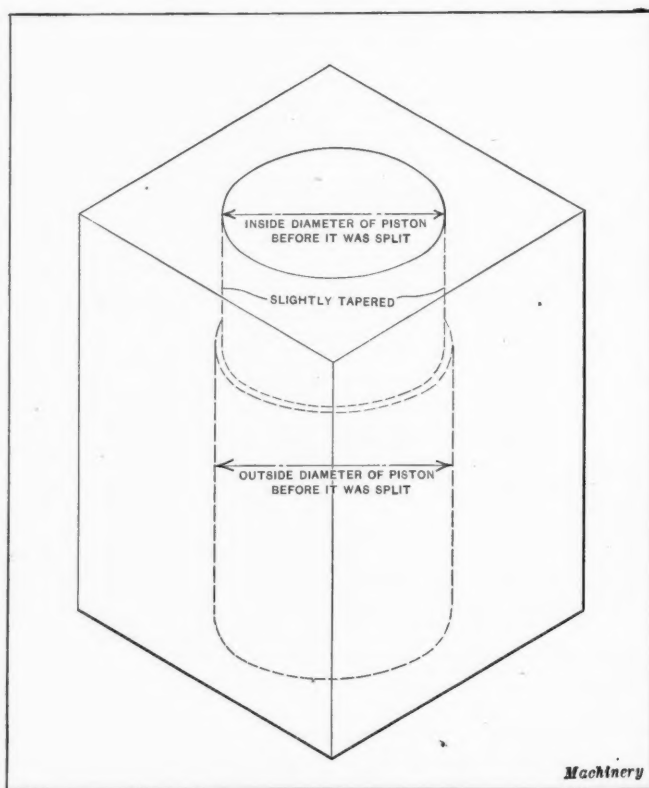


Fig. 3. Detail of Wooden Block in which Split Piston is held

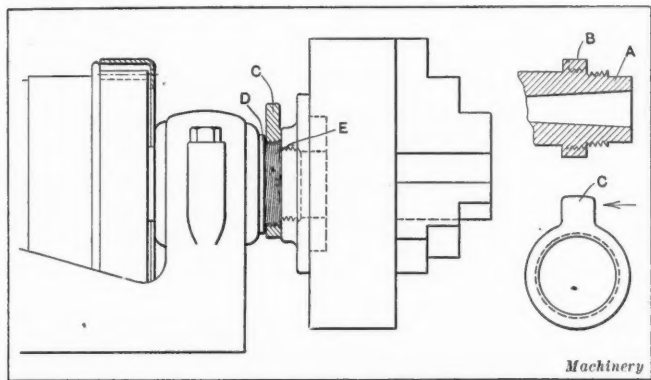
wrist-pin bosses in the new piston, and if this is the case the holes in the bosses of the old piston should be plugged up so that the core will provide for casting solid bosses.

Washington, D. C.

ARTHUR F. ALBERT

PREVENTING LATHE CHUCKS FROM STICKING

We experienced so much trouble with our lathe chucks sticking fast on the nose of the spindle, making it practically impossible to remove them without injury, that it became necessary to find some way of overcoming this difficulty. The trouble, of course, was largely due to ignorance or carelessness on the part of the men who put the chucks onto the



Locking Collar provided on Lathe Spindle Nose to prevent Chuck from sticking

spindle, but these men were employed on a piece-work basis and as a result were likely to grow careless about cleaning the threads on the spindle nose and in the chuck, and also about screwing the chuck up slowly against the shoulder on the spindle. It is impossible to watch everyone in the shop at the same time, and although you may have instructed them in the proper way of doing the work, they will forget such instructions when they are intent upon making a piece-work rate.

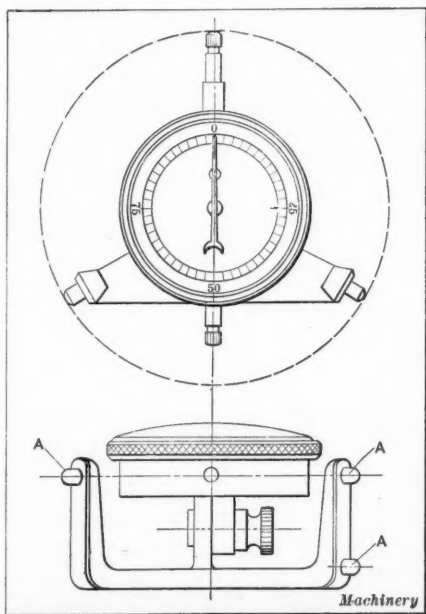
The solution of the difficulty which we finally hit upon is shown in the accompanying illustration, which will need little explanation to make it clear to any mechanic. Referring first to the partial cross-section of the spindle nose shown at A, the full lines show the spindle in its original condition, while the dotted lines at B show how the collar on the spindle was turned down and threaded to receive the collar provided with a tail C. The thread on this collar is made left-hand to fit the thread just cut on the spindle nose. In assembling this device, the collar is first placed on the spindle and screwed up against the shoulder D, after which the chuck is screwed onto the regular thread on the spindle nose in the usual way, care being taken not to screw the chuck quite up to the shoulder E. The collar C is then screwed back against the chuck to lock it in place. When it is required to remove the chuck from the spindle, it is merely necessary to screw back the collar C to loosen the chuck, and if difficulty is experienced in doing this the tail on the collar C may be hit with a lead hammer to drive it in the direction of the arrow.

G. E. P.

CYLINDER TESTING GAGE

There are nearly as many cylinder testing gages in the gas engine factories of the country as there are factories. The writer has experimented with a considerable number, and be-

lieves that the one shown in the accompanying illustration is the cheapest and gives the most accurate results of any he has seen. The indicating mechanism of the instrument shown is simply a dial gage having a plunger with a hardened anvil, the gage being graduated to read to 0.001 inch. This is attached to a two-legged casting by means of a compression thumb nut. In this casting are set three hardened buttons A arranged two on



Inexpensive and Accurate Gage for testing Accuracy of Cylinders

one side and one on the other, giving a three-point bearing. The bearing points are set with an included angle of about 120 degrees from the center line of the cylinder. Two opposite points and the plunger of the dial gage are set in a horizontal plane, the third point being about one-third of the cylinder diameter down one post of the casting. The dial gage is provided with a slip ring so that the pointer may be set to zero no matter what its position may be.

In using the instrument, it is pushed into the cylinder, dial first, from the head or compression end, supposing, of course, that the cylinder head is detachable. By the time the rear point engages with the cylinder bore, the front points and the dial gage anvil are approximately at the point of furthest travel of the piston. With the aid of an electric flashlight the operator or inspector may easily watch the variations in cylinder diameter. The instrument should be shoved through the cylinder slowly, care being taken to have all three points bearing on the cylinder bore. If it is desired to use the instrument as a micrometer, this can be done by setting the pointer at zero in a ring gage of the standard size desired. The indicator itself is not an especially expensive instrument, and ordinary tool-room care in machining the small casting and setting the hardened buttons gives an extremely accurate and comparatively inexpensive cylinder gage.

Charles City, Iowa.

H. E. McCray

DRAWING PAPER CUTTER

The cutter here described was designed for cutting blueprint paper, and the cabinet in the table just behind the cutter holds two 100-yard rolls. The paper passes through



Bench and Cutter arranged for cutting Drawing and Blueprint Paper

two slots in the top of the table and then under the knife. The top of the table is marked off for various standard sizes of sheets, and thus the cutting of the paper is facilitated.

The same cutter is used for cutting tracing cloth and drawing paper into sheets of standard size, the rolls of cloth and paper being hung on the wall just back of the cutter. This cutter has been in use for about twelve years and has paid for itself many times by the saving of material. Where there are a number of small sheets to be cut, the work can be facilitated by handling from three to eight large sheets at a time, depending upon the weight of the paper.

Salem, Ohio.

H. W. WEISGERBER

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

ON OILING TAPS WHEN TAPPING CAST IRON

H. A.—Some of the men in our shop use oil when tapping soft gray iron, and some do not; the latter say that it is of no special benefit and, in fact, claim that it is detrimental to the tap. Please advise me as to what is the best practice in regard to lubricating the tools when tapping, reaming or drilling soft gray iron.

A.—We advise the use of a few drops of machine oil on the tap at each tapping and the same on a reamer for each hole reamed, but no oil for drilling. A few drops of oil when tapping or reaming lubricate the teeth slightly without making an abrasive mixture with the cuttings. A flood of oil is detrimental either for tapping or reaming, and should never be used.

METRIC DRAWINGS

C. M. C.—I am about to make drawings for a number of machines to be built in Europe under the metric system. What is the practice in making metric drawings as regards scales, dimensions, etc?

A.—The custom when making drawings to metric measurements is to express all measurements in millimeters. The reason for not expressing the dimensions in decimeters or meters is the possibility of mistakes due to misplacing decimal points. No matter what the dimension is on a drawing showing machinery or machinery parts, the dimension is expressed in millimeters. This often means numbers of five figures but the rule is invariable. The practice as regards scales is to use full, 1/5 and 1/10 scales; if necessary, 1/20, 1/50 and 1/100 scales may be used, but 1/2, 1/4, 1/8 and other binary division scales are not recommended.

TRUING FILES WITH ACID

J. A. J.—The slide valve of the air brake triple valve operates in a brass bushing on a flat seat about four inches long. The bearing becomes worn in service, and being in a circular cavity, it is usually trued with files. A bastard file is used first, following with a smooth mill file to finish. The files used range from 5/8 to 1 inch square, and are provided with safe edges. Occasionally a new file is found that will not file true, owing to irregularities of the teeth. I have heard that the air brake manufacturers have a process of truing their files with acid, which is kept a trade secret. The process removes the tops of the high teeth, making the cutting faces of the file flat and uniform. Can you give me any information on the method employed for truing files by the acid process?

Any reader having knowledge of a practicable method of correcting the irregularities of files so as to make them suitable for work of this sort will confer a favor by communicating with the editor.

MAKING WOVEN BED-SPRINGS

F. O.—Can you tell me how the so-called woven wire bed-springs are made?

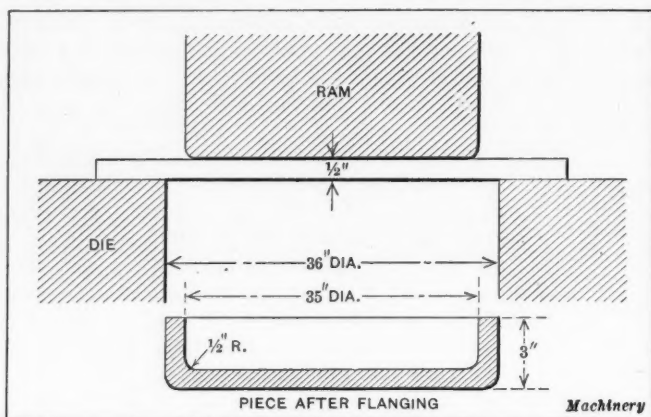
A.—The bed-springs composed of interlaced helical springs are "woven" with a small wire-coiling machine of the projection or extrusion type. The helical coil is formed by shooting the wire through a spiral die at the rate of 800 feet per minute, the wire being driven by a pair of rolls which are started by the operator but which stop driving automatically when the requisite length of coil is formed. The operator cuts off the coil with a pair of wire nippers, and then sets the coil just formed so that the next one projected will interlace with it as it is formed. The operation is a very pretty one, the coil being formed and projected so rapidly that the eye can hardly follow it as it interlaces with the coil previously made. When weaving the edges of the bed-spring, a number of coils are formed in parallel without interlacing. When doing this, the operator does not shift the position of the coil previously formed but allows the next one to run in with it and so on until the required number to form the edge have been "woven" in parallel.

POWER REQUIRED TO CUP A 36-INCH TANK HEAD

E. P. H.—What pressure is required to flange a 1/2-inch steel plate forming a cup 36 inches outside diameter and 3 inches deep, the interior radius at the corner being 1/2 inch?

Answered by Otto S. Beyer, Toledo, Ohio.

A pressure of from 1250 to 1500 tons must be exerted by the press when performing the work cold, provided the yield point of the material is within 40,000 pounds per square inch, but if the plates are heated, the work may be performed at considerably less pressure. If the plates are heated to a temperature of 1375 degrees F.—a temperature at which scale does not form—the pressure required will be only 20 per cent of the pressure required when the plate is cold, or 250 to 300 tons; it will be only 7 1/2 to 10 per cent of that required for forming the cup cold if the plates are heated to



Flanged Tank Head 36 inches Diameter

a white heat—a temperature in the neighborhood of 2000 degrees F. A mechanical press for doing the work cold should be a twin-gear drive double-crank press with a shaft diameter of, say, 17 inches. I would estimate the weight of the press to be between 275,000 and 300,000 pounds. In this connection, would say that up to within a few years ago, tank heads of the kind and size described were generally formed by hydraulic presses, the work being done hot. In later years, however, the mechanical press with its positively controlled punch and greater production capacity and minimum maintenance cost of machine and dies has supplanted hydraulic machinery generally.

* * *

TEN SAFETY COMMANDMENTS*

1. Thou shalt have no thoughts other than those of thy work.
2. Thou shalt take no unnecessary risks, nor try to show off, nor play practical jokes, for by thy carelessness thou mayest do injury which will have effect unto the third or fourth generation.
3. Thou shalt not swear nor lose thy temper when things do not come just right.
4. Thou shalt not clean machinery while it is in motion.
5. Remember that thou art not the only one on the job, and that other lives are just as important as thine own.
6. Honor thy job as thyself, that thy days may be long in employment.
7. Thou shalt not watch thy neighbor's work, but attend to thine own.
8. Thou shalt not let the sleeves of thy shirt hang loose nor leave the flaps of thine coat unbuttoned, as they may get caught in the machinery.
9. Thou shalt not throw matches or greasy waste on the floor, nor scatter oil around bearings, as a dirty worker is a clumsy worker, and a clumsy worker is a menace to his fellows.
10. Thou shalt not interfere with the switches, nor the engines, nor anything else that thou art told is dangerous.

* From "The American Drop Forger."

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

NEW BRITAIN SIX-SPINDLE AUTOMATIC SCREW MACHINE

The single-spindle automatic screw machine was developed to secure a greater production of screws and relatively small turned parts than could be obtained with the engine lathe;

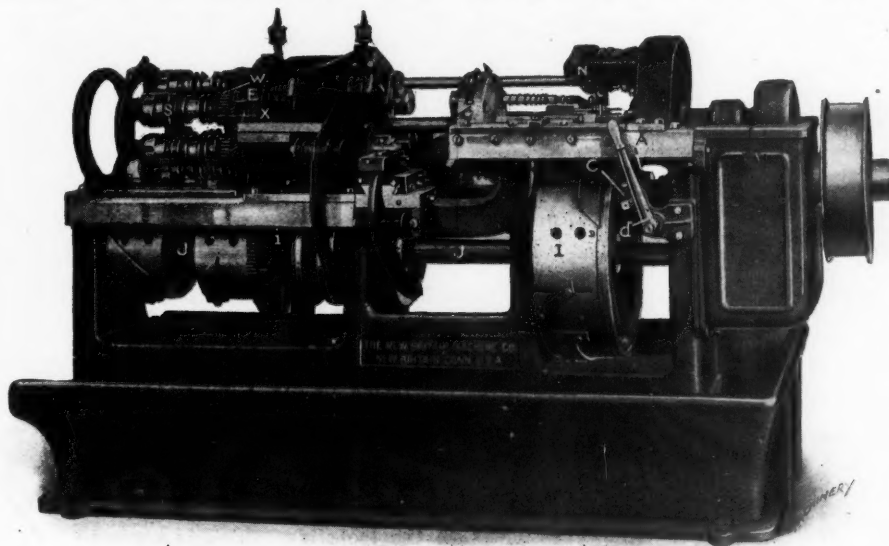


Fig. 1. Front View of New Britain Six-spindle Automatic Screw Machine

and in order to increase the output of such products over that obtained from the single-spindle automatic screw machine, multiple-spindle "automatics" were designed with four and five spindles. The result was that the production of one machine was increased, as four or five operations could be done in the time formerly required for one. The New Britain Machine Co., 64 Bigelow St., New Britain, Conn., has now perfected a six-spindle machine that permits nine operations (including the cross-slide tools) to be simultaneously performed on six pieces, and it is believed that this is the first six-spindle automatic screw machine ever placed on the market. A front view of this machine is illustrated in Fig. 1; Fig. 2 shows a rear view of the same machine equipped with motor drive; and in Fig. 3 the machine is shown from the spindle end. Before going into a detailed description of the machine, an outline of its principal features may be of interest. Of course, the chief distinguishing feature is the provision of six working spindles. It is obvious that with six spindles and the cross-slides, pieces may be produced that require as many as nine operations; and long drilling or turning operations may be freely sub-divided.

In designing this machine particular attention was paid to the development of a heavy base and frame that would be of sufficient rigidity to allow heavy cuts and coarse feeds to be taken. Another important feature is that a ball thrust bearing is fitted on each spindle, which greatly reduces the amount of power required for driving the spindles under the action of the end-working tools. It is claimed that the provision of these ball thrust bearings reduces the power required to drive the spindles fully 30 per cent. The direction of spindle rotation is counter-clockwise, thus permitting the employment of standard tools, no left-

hand cutting tools being required. Irrespective of the spindle speed, the spindle carrier is indexed at a constant speed in every case. Another important feature is the method of driving the threading spindle independently of the other spindles. By means of change-gears the speed of the threading spindle can be varied to suit the particular part that is being threaded, and left-hand threads may be cut. The threading mechanism operates independently of the tool-slide, and the die is run on and off the work at the same time that the turning tools are in operation.

The Drive

Fig. 4 shows a layout of the different drives which transmit power to the main shaft, cam-shaft, indexing shaft, threading shaft, and spindles. In order that these drives may be readily understood, reference letters are used, corresponding letters denoting the same parts. The driving shaft is shown at the extreme right in Fig. 5, and this shaft runs at constant speed. In Fig. 4 the driving shaft is shown with the gear covers removed. At the left-hand end of the driving shaft there is a helical gear *A* that transmits motion to the main shaft *B* through a helical gear *C*. The main shaft passes through the tool-slide and spindle carrier, and at its extreme left-hand end carries a gear *D* whose function it is to rotate the six spindles through gears *E*. (See also Fig. 6.) The drive is carried from the main shaft to the cam-shaft through a small pinion *F* on the main shaft, that meshes with gear *G* on the feed-shaft. (See also Fig. 4.) This feed-shaft carries a pinion *H* that meshes with an internal gear on the feed-cam *I*. Rotation is carried to the cam-shaft *J* through change-gears from the end of the feed-shaft, and these gears may be changed to secure any required speed for the cam-shaft. The drive to the indexing shaft is taken direct from the drive-shaft to the index drive-shaft *K* through spur gearing. The index shaft is in two sections, the forward section being marked *L* and the rear section *M* in Fig. 5. (See also Figs. 2 and 3.) The forward half rotates continuously, but at the time of indexing a clutch connects it with the rear section *M* and the indexing is done through spur gearing and a Geneva motion that will be described later. Power is carried to the threading shaft *N* (see Figs. 2, 3 and 5) through spur gearing direct from the main shaft. At the left-hand end of the threading shaft is a spur gear that is thrown into mesh with

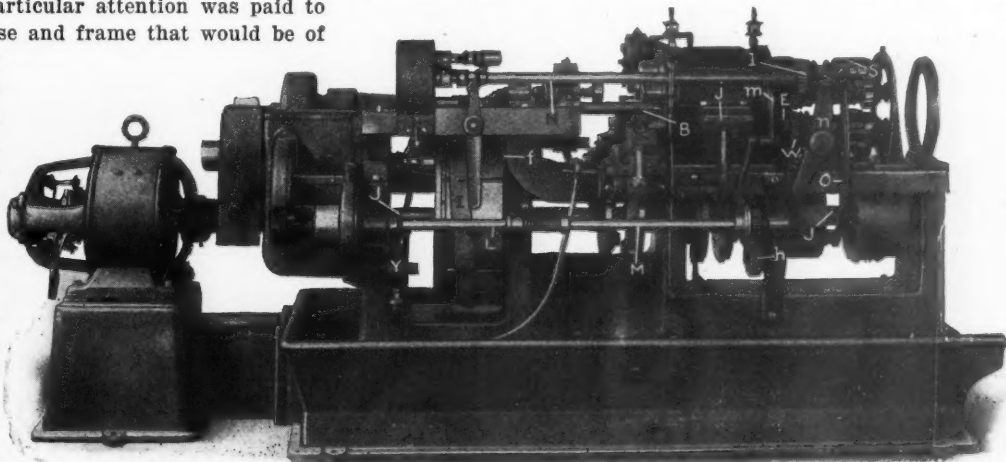


Fig. 2. Rear View of Machine equipped with Individual Electric Motor Drive

the driving gear on the threading spindle for performing the threading operation.

Spindle Construction

Fig. 7 shows a cross-section through one of the six spindles and its bearings. Referring to this illustration, one of the long taper bronze bearings in which the spindles are mounted is shown at *O*. These bearings are ground and may be adjusted for wear by drawing them into their sleeves with the threaded nuts *P*. All the spindle thrust is taken upon the ball thrust bearings *Q* that are set into the frame of the spindle carrier, and receive the thrust of the rotating spindles. The collet chucks, one of which is shown at *R*, are closed on the "push-in" principle, being forced into sleeves on the noses of the spindles. The usual mechanism for closing the chucks is present in the form of fingers *S* that are oscillated and throw the chucks forward into the sleeves. These fingers are operated by clutches; and the manner of operation will be described later. The stock tubes *T* are also of the usual type, and the work is seized by the spring jaws on the chuck-end of the stock tubes. The stock tubes are advanced by the cam mechanism, which will also be described later, this mechanism acting through the sleeve that may be seen on the extreme left-hand end of the stock tube.

The spindles themselves are of liberal diameter and are

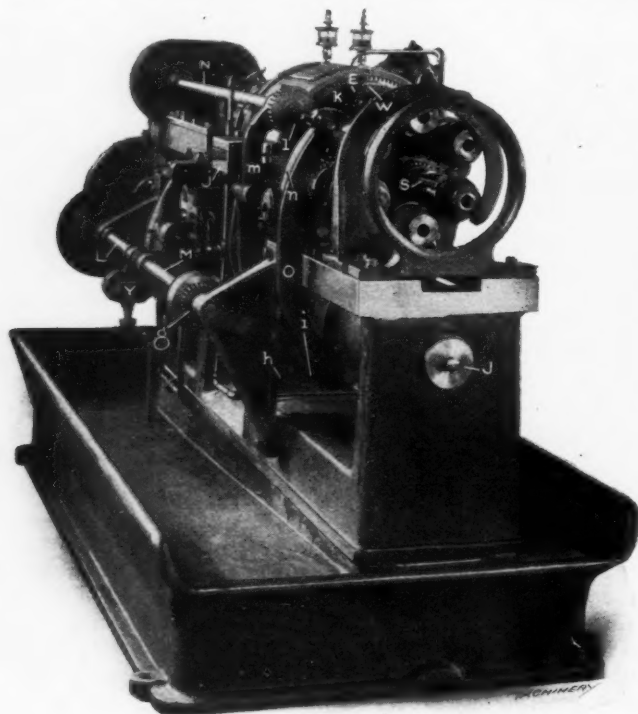


Fig. 3. View of Machine from Spindle End

hammer-forged from chrome-nickel steel, after which they are heat-treated and ground. Lubricant is carried to the spindle bearings through ports *U* in the spindle carrier; these ports carry sight-feed oil reservoirs, as shown in Figs. 1 and 2, and oil is conveyed down into the spindle bearings at each indexing. The spindle carrier has its bearings in the housing at *V*, the bearings being of cast iron. The main shaft of the machine is indicated at *B*, and transmits power to the spindles through helical gear *D* that meshes with gears *E* on the spindles. (See Fig. 5.) The spur gears *W* are for the purpose of driving the spindles when in operation for threading, the gear *W* being slidably keyed to the spindles. At all times except when the spindles are in the threading position, these gears *W* are kept thrust into a taper seat in the gears *E*, and the spindles are driven by the gear *D*. This friction is maintained by fingers *X* that are operated by clutches and yokes. At the time of threading, the clutches are cam-operated so as to release fingers *X*, and the friction drive between gears *W* and *E* is broken; thus at this time the spindles are not driven by the driving gear *D*, as gears *E* slip freely under its action, because its connection with gear *W* is broken. For threading, therefore, it is evident that gears *W*, operated by a special driving mechanism to be described

later, are responsible for the rotation of the spindles. While the main shaft *B* passes through bronze bushings in the spindle carrier, none of the weight of the spindle carrier comes upon it, this weight being all taken on the spindle carrier bearings at *V*. Six speeds are available for the spindles, and these are effected by change-gears that may be placed upon the right-hand ends of the feed-shaft

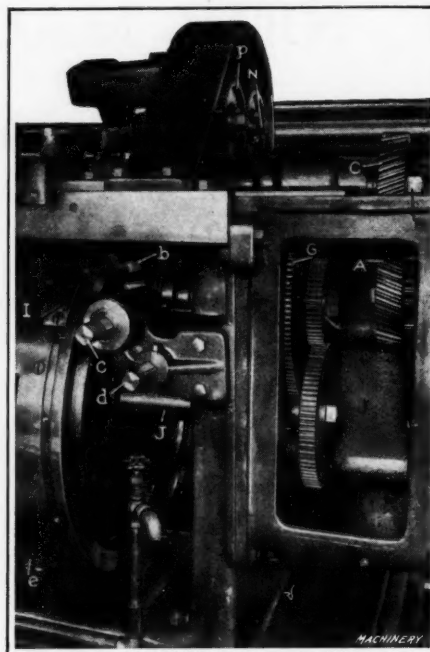


Fig. 4. View of End of Driving Shaft with Gear Guards removed

and cam-shaft, as illustrated in Fig. 5.

The Tool-slide

Fig. 8 shows the operation of the tool-slide to best advantage. Here also may be seen the arrangement of the six spindles, and, of course, there are six corresponding tool holding positions on the tool-slide, which is illustrated at *a*. Attention is called to the fact that the tool-slide is supported in extremely long bearings and that these bearings support the slide centrally from both sides so that there is no cramping action in its movement. While the main shaft *B* passes through a bronze bushing in the tool-slide, it receives none of the weight of the slide. There is no overhanging of the tool-slide in its bearings at any time during its movement. Fig. 4 gives the best idea of the operation of the tool-slide which, of course, is through the cam-drum *I*. Upon this drum are placed the cams that govern the operation of the slide and they act through a stud on the lower part of the tool-slide that is not visible in the illustration. The cam-drum is kept free from back-lash by a hardened steel roll *b* supported from the frame, that runs against the right-hand edge of the drum.

As previously mentioned, the cam-drum is driven by an internal gear and pinion shown at *H* in Fig. 5; and within the cam-drum in Fig. 4 may be seen the internal teeth with which the pinion meshes. This requires less power than would be the case if the power were transmitted to the cam-shaft direct, and the gear tooth action is better. A stud *c* carries a bevel pinion that meshes with a corresponding bevel gear on the feed-shaft which carries the small pinion *H*; and thus

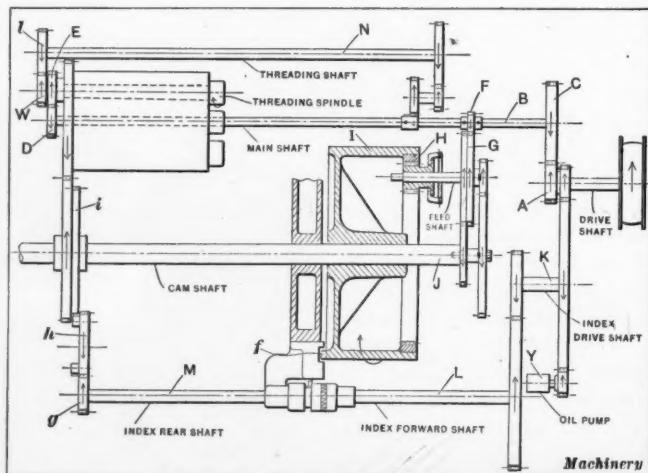


Fig. 5. Arrangement of Drive on New Britain Six-spindle Automatic Screw Machine

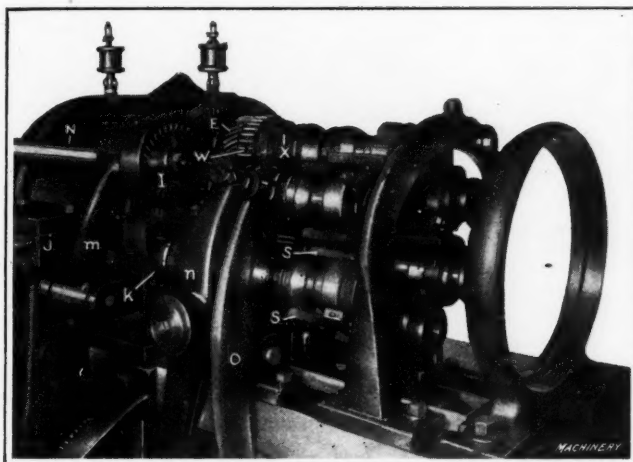


Fig. 6. View of Spindle Driving Gears

means are present for turning the cam-drum by hand when setting up the machine. A hand lever on stud *d* operates a clutch for disengaging the cam-shaft at any desired time, thus stopping the action of the tools. This clutch may also be thrown out from the rear of the machine. Attention is called to the fact that a laminated cam is made use of on the feed drum. This is a patented cam construction, in which the cam strip is composed of three leaves, which permits of the adjusting of one cam to any length of work within the capacity of the machine. An edge view of one of these laminated cams may be seen at *e* in Fig. 4. In order to save the laminated cam the shock of commencing its work, a solid block is placed on the drum ahead of it to take the shock of starting.

The Indexing Mechanism

The indexing of this machine is done at constant speed, irrespective of the speed of the main shaft or cam-shaft. When the indexing of a screw machine is done from the cam-shaft, the indexing motion is performed in a definite ratio to that of the other movements emanating from the cam-shaft. In the case of a very short job of turning, requiring say about ten seconds, the movements of the machine take place rapidly and the indexing is done at a correspondingly high speed. If, on the other hand, the job is a slow and difficult one, the indexing is also done very slowly in proportion. The indexing of the New Britain six-spindle machine takes place at a constant speed without regard to the length of the job on the machine. Referring to Fig. 5, it will be seen that there is no connection with the cam-shaft for indexing. By looking at this illustration in connection with Fig. 2, the method of indexing may be readily followed. As has been explained, the index shaft is in two sections—the forward section *L* that revolves continuously, and the rear section *M* that revolves only at the time of indexing. A clutch connects the two sections of the indexing shaft; and at each revolution of the cam-drum this clutch is tripped by the small edge cam *f*, Fig. 5. When the clutch is tripped, and the rear index shaft is caused to turn, gear *g* turns gear *h* through exactly one-half revolution, because gear *g* is just one-half the diameter of gear *h*.

Diametrically opposite each other on the side of gear *h* are two studs that operate the Geneva gear *i* which may be more clearly shown in the front view, Fig. 1, and also in Fig. 8. This gear is supported, but not driven, by the cam-shaft. The operation of the stud in the slot in the Geneva gear turns it exactly one-sixth of a revolution, and as this gear *i* is in mesh with the gear *k* of the spindle carrier (see Fig. 6) which is of the same diameter, the spindle carrier is also turned one-sixth of a revolution. Just previous to the indexing, a cam and cam-lever operated from the cam-shaft withdraw the locking bolt shown at *j* in Fig. 2. This is a wide heavy key that is normally kept in contact with the spindle carrier by spring pressure, engaging in one of the six slots equally spaced about the circumference of the spindle carrier. The cam releases the key so that when the spindle carrier is turned far enough to engage the locking bolt, it shoots into place and holds the spindle carrier until the time of next indexing. It is claimed that the Geneva motion is particularly adaptable to indexing mechanisms in that the starting motion is slow, gradually accelerating and then diminishing at the end of the motion.

The Cross-slide

The cross or forming slides of this machine are three in number, operating on the second, third, and sixth spindles. Provision has also been made for adding a cross-slide to the fourth spindle if the work to be performed requires it. Fig.

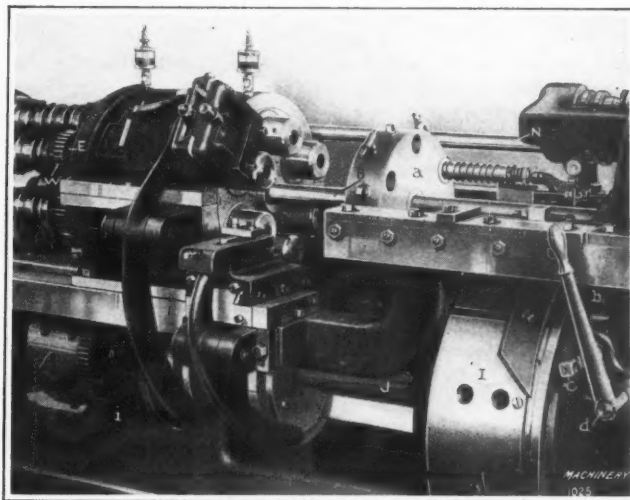


Fig. 8. Illustration of how Tool-slide operates

8 clearly illustrates the second and third spindle cross-slides, and their operation takes place by means of cam-levers operating from plate-cams on the cam-shaft. The rear cross-slide may be readily seen in Fig. 2, and is used principally for cutting off. The stock-feeding and chuck-closing operations are performed from the cam-drum at the extreme end of the cam-shaft. This operates on the clutches that feed the stock and close the chuck on the spindle in the first or lowest position, which is just above the top surface of the cam, as may be seen in Fig. 2.

The Threading Spindle

The method of performing threading operations on this screw machine is somewhat different from the practice with

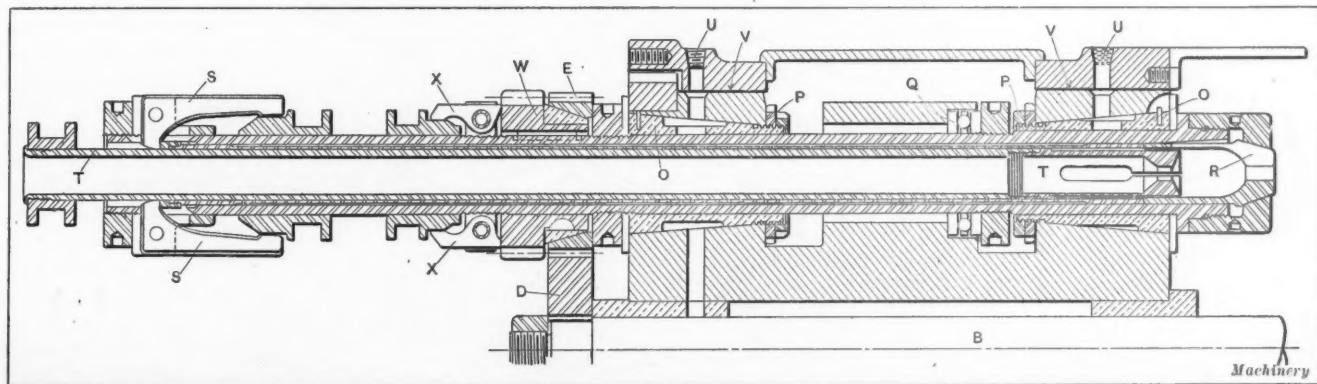


Fig. 7. Cross-sectional View of One of the Six Spindles of New Britain Automatic Screw Machine

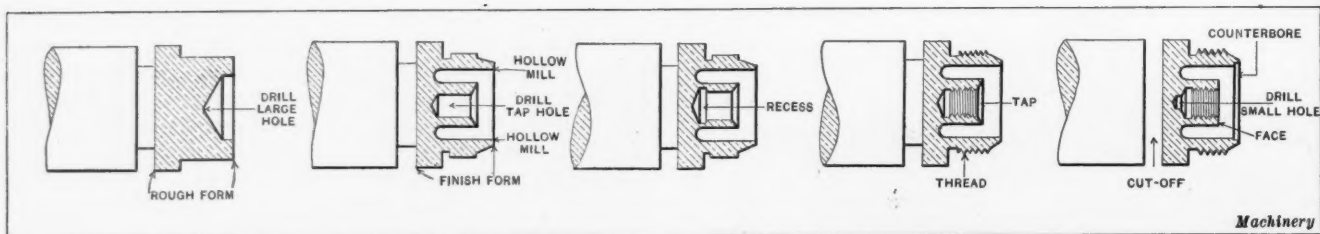


Fig. 9. Example of a Job done on New Britain Six-spindle Machine

other types of machines. Figs. 2, 3 and 5 illustrate this part of the machine to advantage. The threading shaft is shown at *N* and rotation is carried to it as has been explained in connection with Fig. 5. This shaft is mounted at the left-hand end, as viewed in Fig. 2, in a floating bearing that permits the entire shaft to be oscillated, thus allowing the gear *l* on the opposite end to be thrown into or out of mesh with the spindle gear *W* when actuated by lever *m* that is guided by a cam on the cam-shaft. The operation of this threading shaft is as follows: Just before the spindle carrier is indexed, the threading shaft and its gear are thrown away from the spindle to give the spindle carrier a clear path for indexing. As soon as the locking bolt has shot into place, a rise on the cam that governs lever *m* carries this lever back into its inner position with the gear in mesh with the gear *W* on the spindle at the threading position.

Simultaneously with this action lever *n* is operated by the cam on the cam-shaft and operates the spindle clutch that releases the spindle driving gear *E* from contact with the gear *W* that is now in mesh with the gear *l* on the threading spindle. By this means the spindle is operated at the correct threading speed. Before the indexing takes place, the threading shaft is again swung away and gear *l* is thrown out of mesh with the spindle gear. In addition to lever *n* as shown in Figs. 2 and 7, a brake lever *O* is operated from the cam-shaft. The upper end of this lever is fitted with a fiber plug and its function is to bear against the spindle and retard rotation just before the threading shaft gear *l* goes into mesh with the spindle gear. On the left-hand end of the threading spindle is a reversing shaft by means of which a left-hand rotation may be given the shaft when left-hand threads are to be cut. These reversing gears may be seen at *p* in Fig. 4, but are omitted in Fig. 5. Fig. 8 shows the threading die or tap-holder held on the tool-slide. This is fitted with a pusher-arm that presses against the rear of the holder to engage the threading die or tap on the work, after which it "leads" itself on. Spring fingers prevent the threading die holder from turning when in action.

Lubrication for the cutting tools is supplied through an oil pump that is direct-connected from the index drive-shaft. This may be seen at *Y* in Fig. 2, and the cutting lubricant is carried through piping to the center of the tool-slide. From this point internal passages in the tool-slide carry the lubricant to the six cutting points, thus obviating much visible piping. By referring to Fig. 3, which clearly shows the shape of the frame and base of the machine, it will be seen that the problems of chip clearance and oil drainage are well taken care of. Beneath the operating stations, the bed is cut away at an angle of 45 degrees to conduct the lubricant

and chips to the base. The base is inclined to drain the oil down to the rear end of the machine, from which point it is pumped out and up to the lubricating point.

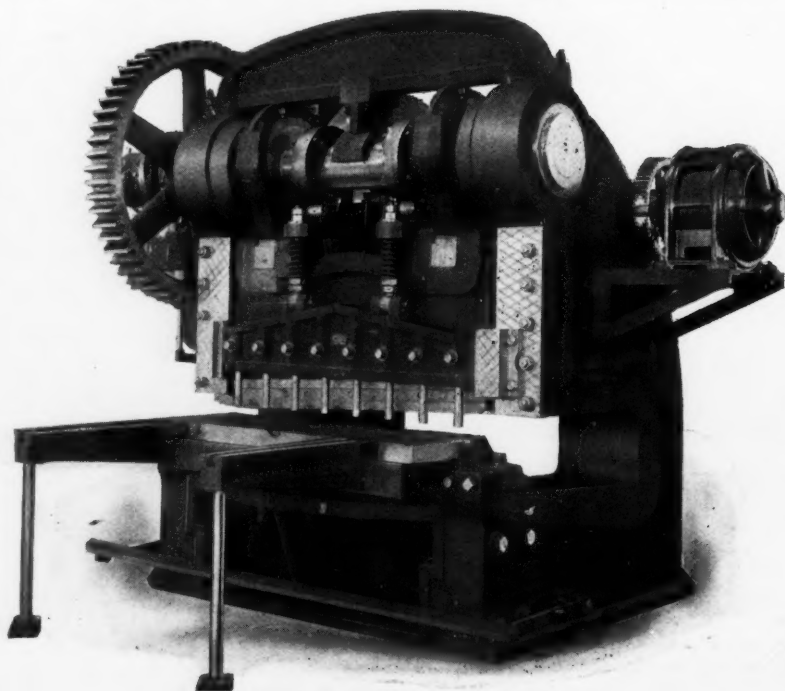
This machine may be furnished with either belt or motor drive, and is built in four sizes, namely, $\frac{5}{8}$ inch by $3\frac{3}{4}$ inches, weighing 4000 pounds; 1 inch by 5 inches, weighing 5600 pounds; $1\frac{1}{2}$ inch by 7 inches, weighing 10,200 pounds; and $2\frac{1}{2}$ inches by $9\frac{1}{2}$ inches, weighing 16,000 pounds. Fig. 9 shows the sequence of operations in making a screw machine product, and clearly indicates the advantages of the machine. This part would be difficult to produce on a machine having less than six spindles. The first operation of feeding the stock at the first spindle position is not shown. At the second position the piece is rough-formed and the large hole drilled. At the third position the piece is finish-formed, hollow-milled and the tap hole is drilled. At the fourth position, the tap hole is recessed. At the fifth position the outside diameter is threaded and the hole tapped. Then at the sixth and last position, the small hole is drilled, the end faced and the piece cut off complete.

BERTSCH GATE SHEAR

A recent product of Bertsch & Co., Cambridge City, Ind., consists of the heavy gate shear which is illustrated and described herewith. This machine has 72-inch blades and capacity for cutting $1\frac{1}{4}$ -inch plates the full width of the machine. In order to stand up under this severe service the construction is made exceptionally heavy. The housings are supported by a cross-tie at the rear of the gate and another cross-tie overhead. The press is equipped with a toggle-joint automatic clutch, the action of which is positive and noiseless. The toggle-joint principle increases the engaging pressure, thereby insuring a full contact of the jaws. The clutch is disengaged by means of a hardened steel roller which runs on a renewable cast steel switch ring or sleeve.

DIAMOND SHEAR GRINDING MACHINE

The Diamond Machine Co., Providence, R. I., has recently



Bertsch 72-inch Heavy Gate Shear

completed two of what are believed to be the heaviest shear-blade grinding machines that have ever been built. These machines weigh about 10 tons each; the length of the beds is 24 feet, the operating space $47\frac{1}{2}$ feet, and the capacity for grinding shear blades up to 180 inches in length. The knife bar is designed with bearings at intervals of $2\frac{1}{2}$ feet, which rest on bab-bitted supports, the thrust of the grinding wheel being adequately supported in this way. The bar is adjusted to the required angle by means of a worm which is operated by a hand-wheel; and by removing the knife bar, the

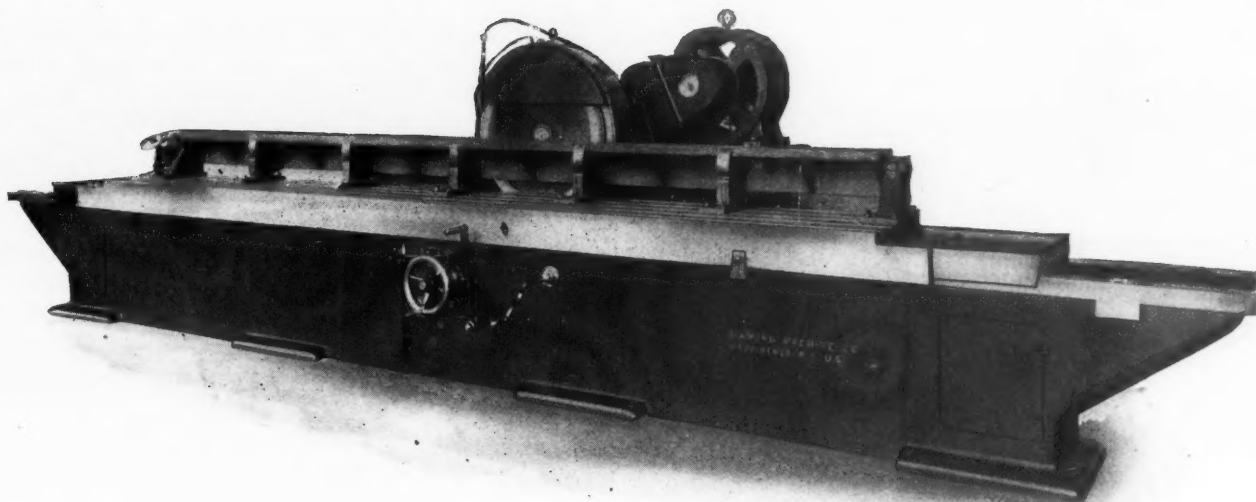


Fig. 1. Diamond Shear-blade Grinding Machine, said to be the Largest Grinder of its Kind ever built

machine is made applicable for face grinding through a vertical limit of 24 inches and a horizontal limit of 180 inches. In this way the machine may be used for face grinding operations when there is no knife grinding to be done.

The machine is similar to the heavy face grinding machine built by the Diamond Machine Co. The patented rear control is employed, by means of which the operator is enabled to handle all levers from the rear, which is the position from which he can most advantageously watch the progress of the grinding operation. Front control is also provided for use in setting up. The table is shifted by a system where the dogs merely remove a stop, thus allowing the shifting mechanism to come into play. This method insures positive and quiet operation. The spindle is of large diameter and carried in long phosphor-bronze ring-oiling bearings. The machine is self-contained, being driven from a single motor connected by gears or a chain drive. A vertical spindle pump with all bearings above the water level, as shown in the illustration Fig. 3, provides the required amount of water, and the guards are designed to effectively prevent water being thrown onto the floor, the water being returned to the settling tank.

WOODS BORING AND GRINDING ATTACHMENT

For use in garages and machine shops which handle automobile repair work, the Woods Engineering Co., Alliance, Ohio, has developed a boring and grinding attachment for use on the milling machine or lathe. This attachment is

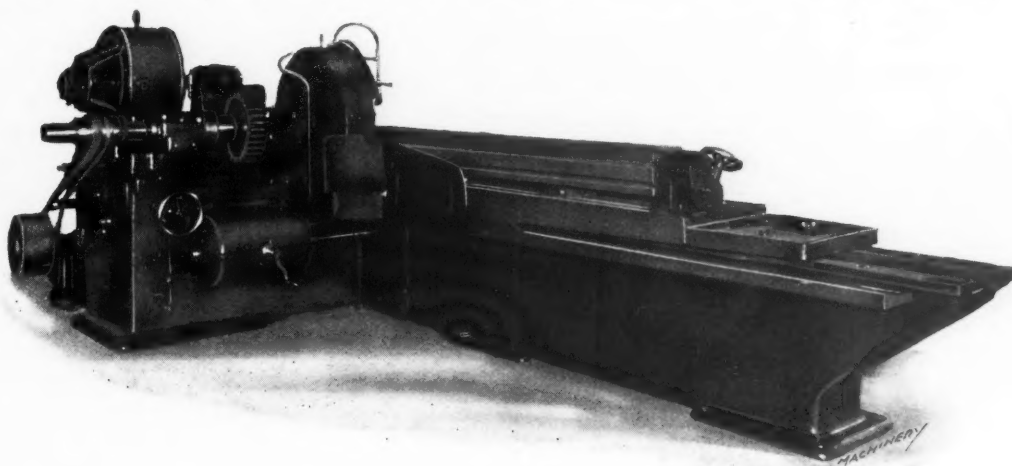


Fig. 2. End View of Diamond Shear-blade Grinding Machine, showing Arrangement of Drive and Rear Operating Mechanism

intended for use in reboring and grinding scored or worn automobile cylinders and other work of a similar character. The attachment without the countershaft is shown in Fig. 1, and Fig. 2 shows it set up on a No. 3 Kempsmith milling machine. The range of the attachment is for grinding holes from $2\frac{1}{2}$ inches in diameter up, and 11 inches in depth. It

is provided with a 2-inch eccentric micrometer adjustment, and a $2\frac{3}{8}$ -inch and a $3\frac{1}{2}$ -inch wheel will grind all holes with diameters from $2\frac{1}{2}$ inches up to $5\frac{1}{4}$ inches; larger diameters require correspondingly larger grinding wheels.

The spindle of the attachment is mounted in double-row S. K. F. annular ball bearings which are provided with means for excluding grit and retaining the lubricant in the bearing. The driving shaft also runs in ball bearings. Where it is feasible to do so, the countershaft is mounted on

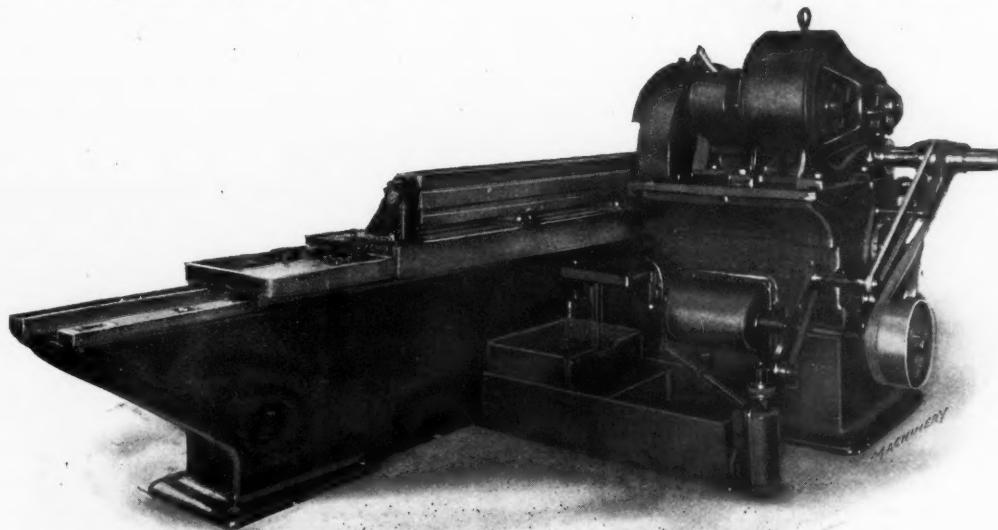


Fig. 3. Rear View of Diamond Grinder showing Arrangement of Settling Tank and Pump

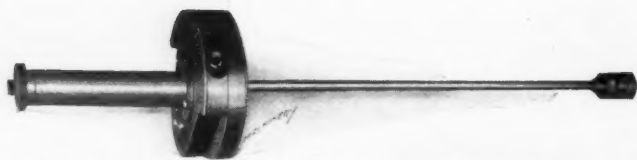


Fig. 1. Woods Boring and Grinding Attachment without Countershaft

the over-arm of the milling machine as shown in Fig. 2; and when mounted in this way the countershaft is provided with adjustment for maintaining the required belt tension. The entire attachment can be set up or removed in a very short

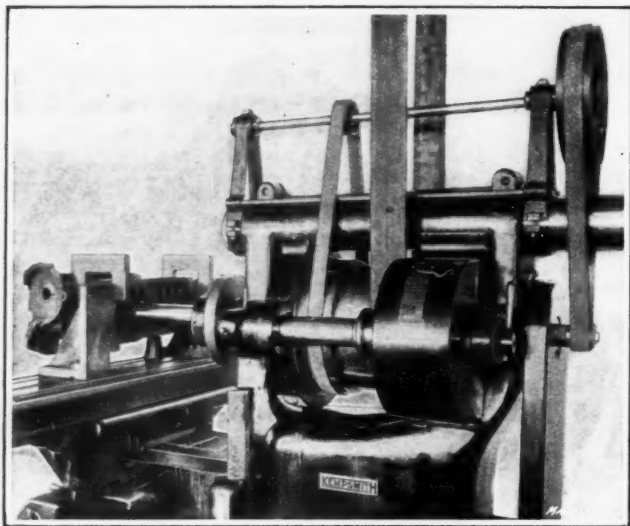


Fig. 2. Woods Boring and Grinding Attachment set up on No. 3 Kempsmith Miller

time. When used on a lathe the countershaft is mounted overhead and the angle plates on which the cylinder is held are carried on a sliding base fastened to the lathe carriage. A vertical and longitudinal movement are provided to facilitate setting.

When a cylinder is so badly scored that it is necessary to bore it before grinding, a boring head is provided for use on the attachment in place of the emery wheel. The change from the boring head to the grinding wheel or *vice versa* requires very little time.

GREENFIELD INTERNAL GUIDE FOR PIPE THREADING TOOLS

Fig. 1 shows an internal guide for pipe-threading tools which has been developed by the Greenfield Tap & Die Corporation, Greenfield, Mass., for guiding the die to insure



Fig. 1. "Little Giant" Internal Guide for Pipe Threading Tools

obtaining a straight thread; and Fig. 2 shows the trio pipe-threading die-stock of this company's manufacture equipped with the new guides. In addition to serving as a guide, it will be seen that a reamer point is provided which removes the burrs from the inside of the pipe as the guide enters,



thus performing two operations simultaneously. The same form of guide is fitted to the duo pipe-threading die-sets, the pipe-threading sets for ceiling work, the ratchet pipe-threading die-stock and the die-stocks for threading thin metal tubing which are manufactured by the Greenfield Tap & Die Corporation.

STEPHAN EMERY WHEEL DRESSER

The C. H. Stephan Mfg. Co., 10-11 Mitchell Bldg., Springfield, Ohio, has recently placed an emery wheel dresser on the market in which the abrasive is furnished in the form of a stick. This stick fits into a tube which is made in two halves and held tightly in place by three tapered sleeves. The arrangement will be readily understood by referring to the accompanying illustration which shows the dresser with the three tapered sleeves and one-half of the tube removed. As the abrasive stick wears down, the tapered sleeves may be removed so that only the stick and the tube are used up.



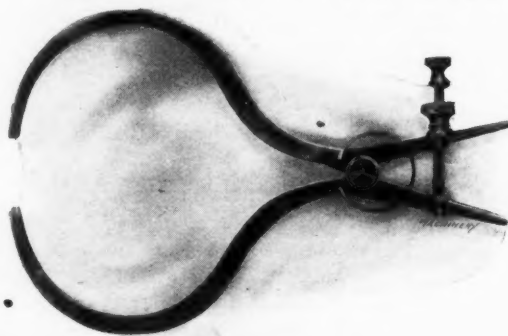
Parts of Stephan Emery Wheel Dresser

The possibility of using the same handle and sleeves over and over is the means of effecting an economy in the cost of dressers.

It will be seen that the handle has a small groove turned about 1 inch from the small end, and each half of the tube is made with a bead which drops into this groove in the handle. The tubes are stamped out under a punch press so that they are quite inexpensive. The abrasive stick is composed of a cutting material practically as hard as black diamond which is carried by a bond that is fused to enable the stick to be molded into the tapered form shown in the illustration.

PITTSBURG LOCK-JOINT CALIPER

The lock-joint caliper shown in the accompanying illustration is a recent product of the Pittsburgh Instrument Co., 236 Third Ave., Pittsburgh, Pa. This tool is adapted for general use, but is particularly intended for calipering the inside of chambered cavities, reaching over flanges and for

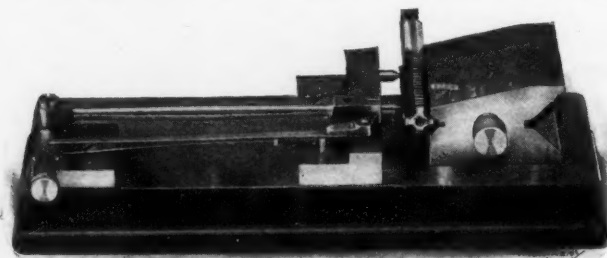


Pittsburg Lock-joint Caliper

making other measurements of a similar character, as the locking device enables the caliper to be removed from such work after which the measurement can be taken in the usual way. Further description is unnecessary to make the use of the tool perfectly clear to any mechanic.

REMINGTON SCREW LEAD INDICATOR

Considerable interest has recently been taken in the establishment of standard screw thread tolerances, and investiga-



Remington Indicator for testing Threaded Parts

tions which have been conducted have shown that the pitch or lead of the thread is a most important factor in securing interchangeability of threaded parts. For the purpose of testing the lead of a screw or tap, the Remington Tool & Machine Co., Woburn, Boston, Mass., has developed a screw lead indicator which is shown in the accompanying illustration. The design of this instrument will be readily understood from the illustration. In this connection, it is important to know that the hardened 60-degree points are spaced either $\frac{1}{2}$ or 1 inch apart and that the screw-holding block is milled to receive work of various diameters. Standard plugs are provided with the indicator for use in making accurate settings.

WEST HAVEN UNIVERSAL HACKSAW FRAMES

The Nos. 11 and 14 universal hacksaw frames which constitute recent additions to the line of the West Haven Mfg. Co., New Haven, Conn., are illustrated in Figs. 1 and 2. Fig. 1 shows the No. 11 frame with automatic grip extension, which is particularly intended for use out of doors or in any place where the tool will not receive the best of care. The

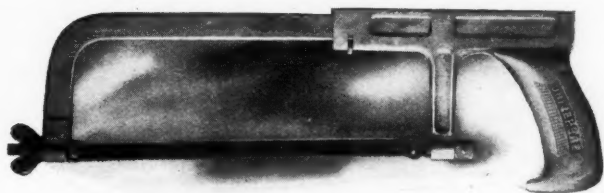


Fig. 1. No. 11 West Haven Hacksaw Frame

"easy grip" handle is hollow so that excessive weight is avoided and the entire frame is sherardized so that it will not rust. This frame takes blades from 8 to 12 inches in length and is made of crucible steel.

The No. 14 frame shown in Fig. 2 is also provided with the "easy grip" handle. It will be seen that this frame is quite similar to the No. 11 style except that it is nickel plated and provided with a new housing for the back which

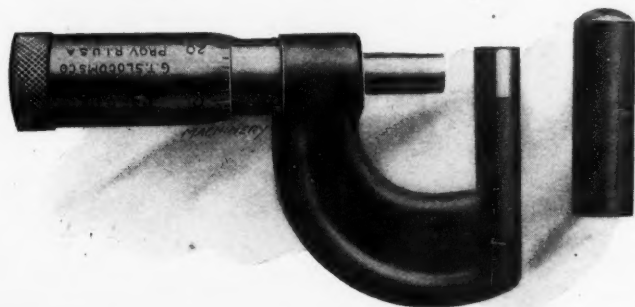


Fig. 2. No. 14 West Haven Hacksaw Frame

gives the frame uniform rigidity when using all sizes of blades from 8 to 12 inches. The housing is extended $2\frac{1}{4}$ inches from the post, thus providing a "solid-back" adjustable frame.

SLOCOMB BULLET-JACKET MICROMETER

The accompanying illustration shows a special micrometer developed by the J. T. Slocomb Co., Providence, R. I., for the purpose of measuring the walls of bullet jackets. This tool is made from the regular Slocomb $\frac{1}{2}$ -inch micrometer, the lower end of the frame of which has been cut off and the small plug welded in place as shown in the illustration. The



Slocomb Micrometer designed for Use in measuring Bullet Jackets

hole in the bullet jackets to be measured is 0.275 inch in diameter, and in using the micrometer the jacket is slipped over the plug and the thickness measured in the usual way. Measurements may be made to a depth of $\frac{5}{8}$ inch. In this connection it should be noted that while the micrometer was made for a special purpose, it is also available for making general classes of measurements.

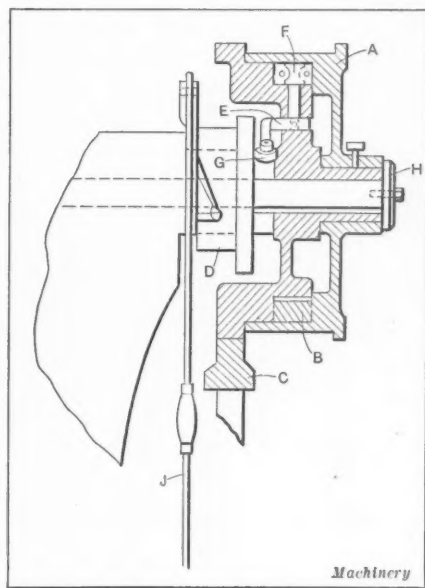
BEAUDRY FRICTION CLUTCH

In connection with the application of electric motor drive to the power hammers which they manufacture, Beaudry & Co., Inc., 141 Milk

St., Boston, Mass., have developed the friction clutch which is illustrated and described herewith. The essential parts of this clutch consist of the pulley A, friction ring B, brake C, cam D, lever E, expansion pin F, roller G and washer H which holds the pulley in place.

The friction ring B is split to fit over the head of the expansion pin F and steel inserts are provided in the ring to afford protection against wear. The brake section C is keyed to the shaft and the pulley A runs loose on the hub of the brake, a grease cup being provided to lubricate the pulley bearings. The cam D is of spiral form, and is held in the neutral position through the action of a spring. The roller G is hardened and runs in a slot in the lever E.

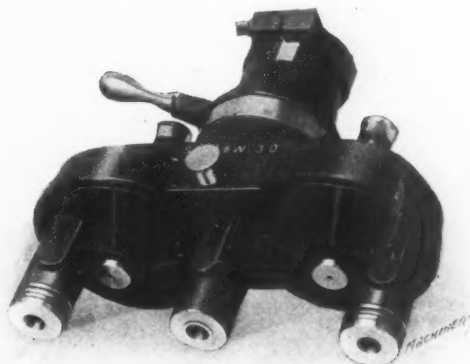
This clutch gives the operator perfect control of the hammer. By applying a light pressure, the pulley is allowed to slip, thus causing the hammer to deliver a light blow; and by increasing the pressure on the treadle, a heavier blow is obtained. It will be evident from the illustration that pushing down the treadle rod J causes the expansion pin F to tighten the friction ring B between the pulley A and brake C through the action of lever E, roller G, and cam D.



Friction Clutch used on Beaudry Hammers

IMPROVED SELLEW DRILL HEAD

The multiple spindle drill heads manufactured by the Sellow Machine Tool Co., Pawtucket, R. I., which have been



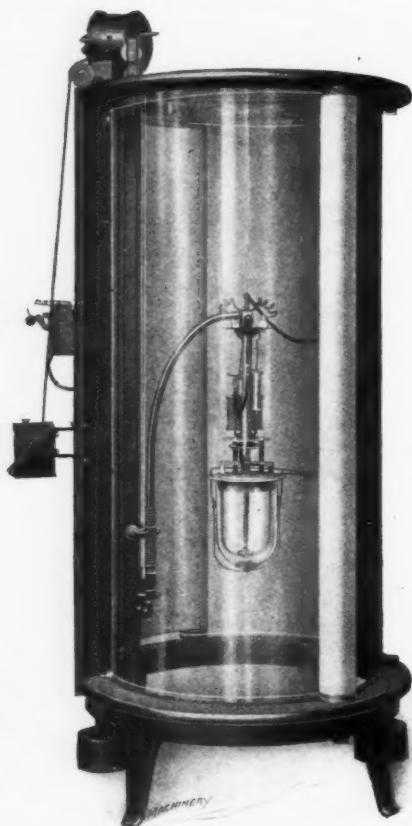
Sellow Drill Head provided with Means of Adjustment around Quill

described in recent numbers of MACHINERY, were designed in such a way that they had to be set in a predetermined position on the quill of the drilling machine. This meant that the spindles were arranged either lengthwise or crosswise of the

table and that the work must be put under the head to suit the position of the spindles. Recently the design of the Sellow drill heads has been modified to enable the head to be swiveled around on the quill of the drilling machine to suit the position of the work. This adjustment is accomplished by means of a clamping ring provided with a frictional taper joint and clamping lever. Only a slight turn of the lever is necessary to release the lower part of the head so that it may be swiveled around on the split sleeve at the top and then clamped in the desired position. It will, of course, be understood that the adjustment of the spindles of the head relative to each other is not in any way affected by the provision of this swivel adjustment of the head.

BUCKEYE BLUEPRINTING MACHINE

The Buckeye Engine Co., Salem, Ohio, has recently made several improvements on the vertical cylinder blueprinting machine which it manufactures. Among these improvements the following are noteworthy: An oil governor is provided to regulate the speed at which the arc lamp moves down through the cylinder, and a safety stop is provided on each machine which makes it impossible for the lamp to drop in case the cable which supports it should break. The oil governor consists of a pump which is driven by a drum around which the lamp cable is wrapped. This pump forces the oil through an orifice, the size of which may be regulated to adjust the speed at which the lamp moves.



Improved Buckeye Blueprinting Machine

An automatic cut-out is provided on all machines, making it unnecessary for the operator to give the machine his entire attention until the print is finished. By means of this cut-out, the current is automatically shut off when the lamp reaches the bottom of the cylinder. A movable crane is provided that reduces the height of each size of machine by about 7 inches, which is of advantage in rooms where the ceiling is low. Other features of the machine are the same as those of the well-known vertical cylinder type of blueprinting machine which has been built for years by the Buckeye Engine Co.

BUFFALO SLITTING SHEARS

The Buffalo Forge Co., Buffalo, N. Y., has recently added to the line of punches and shears with the main frames constructed of armor plate, a series of slitting shears with capacities for cutting plates ranging from $\frac{1}{8}$ to 2 inches in thickness. A noteworthy feature of these machines is the small amount of floor space which they occupy. This is largely due to the great strength of the armor-plate frame construction which enables the machines to be compactly designed. The illustrations show the ample amount of clearance which is provided in the frame to enable the stock to feed through smoothly and avoid distortion. The base is made of angle iron and securely riveted in place.

In working out the design of these machines, particular

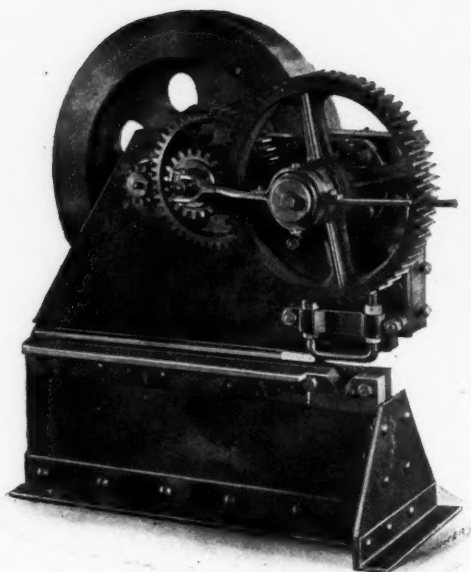


Fig. 1. No. 24 Buffalo Slitting Shear built with an Armor Plate Frame

attention has been paid to those features which provide for quiet, smooth operation. All gears have machine cut teeth, and the bearings are of ample proportions and bronze bushed. The plunger is of cast iron and accurately fitted between the frame and guide, the latter being bolted and doweled to the frame. Taper gibs are provided for taking up wear. The crank is made of cast steel and engages a tempered tool steel block. All shafts are accurately ground to size, and the flywheel shaft is lubricated by means of an oil ring, the flywheel being made large enough to enable the machine to cut stock of the maximum thickness for which it is adapted, for the full length of stroke without the flywheel slowing down more than 10 per cent.

The clutch with which these machines are regularly equipped is of the two-jawed type, and the jaws are reinforced with tempered tool steel pieces to prevent wear. The operator can run the machine continuously or make one cut and then stop in any required position. These machines are equipped with an adjustable stripper and are driven by the usual arrangement of tight and loose pulleys. The No. 24 machine will slit plates up to $\frac{1}{2}$ inch in thickness and will cut off round or square bars up to $\frac{3}{4}$ inch, flat bars $2\frac{1}{2}$ by $\frac{5}{8}$ inch, and angle irons up to 3 by $\frac{1}{4}$ inch. The floor space occupied is 3 feet 6 inches by 2 feet 6 inches, and the weight of the machine 1500 pounds. The No. 25 machine will slit plates up to $\frac{5}{8}$ inch in thickness and cut off round or square bars up to 1 inch, flats 3 by $\frac{3}{4}$ inch, and angle irons up to $3\frac{1}{2}$ by $\frac{3}{8}$ inch. The floor space occupied by the machine is 4 feet 2 inches by 3 feet, and the weight 2200 pounds.

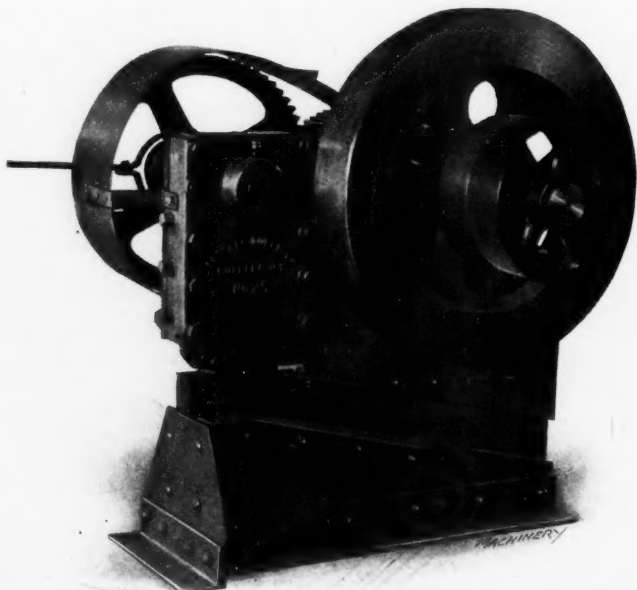


Fig. 2. No. 25 Buffalo Slitting Shear built with an Armor Plate Frame



Fig. 1. Elevating Truck made by Chase Foundry & Mfg. Co.

CHASE ELEVATING TRUCK

There are many factories where material savings in the cost of production have been effected through the adoption of carefully worked out methods of passing the work along from department to department. In handling many classes of work a considerable amount of time is saved through the use of elevating trucks which are used in connection with skids or platforms upon which the work is carried. The accompanying illustrations show an elevating truck which has recently been placed on the market by the Chase Foundry & Mfg. Co., Columbus, Ohio. A feature of this truck is that the tongue may be turned at right angles to enable very short turns to be made, and this position of the tongue may be obtained just as readily when the truck is loaded as when it is empty. This is a valuable feature when handling work in busy factories where space is at a premium.

The elevating device is made of malleable iron and steel; it is of simple construction, locks automatically when raised, and releases automatically by the movement of the handle when letting the load down. The operator has full control at all times. The wheels are turned smooth on the face and are equipped with roller bearings. When it is necessary to protect the floors or when the noise made by cast-iron wheels would be objectionable, the trucks may be equipped with fiber wheels. Fig. 1 shows the truck empty and illustrates the way in which the tongue may be turned at right angles with

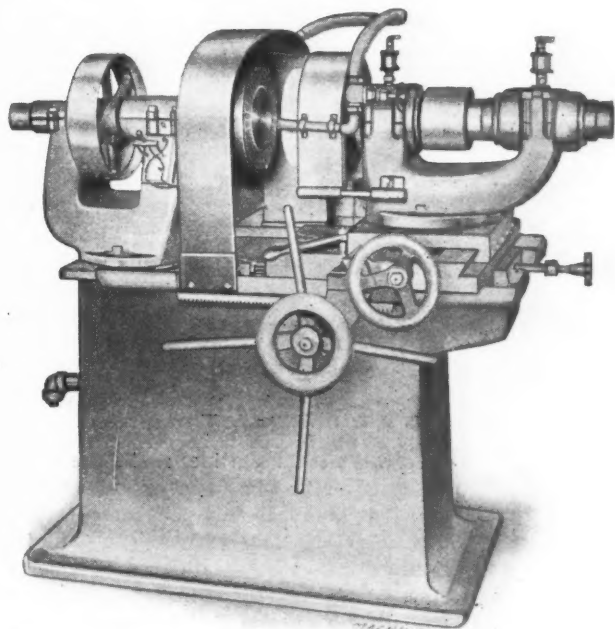


Fig. 2. Chase Elevating Truck in Use

the truck body; and Fig. 2 shows the truck in use with the regulation portable platform on which the work is loaded. For handling small or odd shaped pieces of work, portable bins may be used in place of the platform shown in Fig. 2.

BRIDGEPORT FACE GRINDER

The No. 28 face grinder equipped with a rotary magnetic chuck, which is shown in the accompanying illustration, is a recent product of the Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn. The work head of this machine may be swung around to any angle to provide for grinding concave or convex work, and the wheel head may also be swung around so that when using a cup-wheel only part of the cutting rim comes into contact with a piece of work which is being ground concave or convex. The work head has long self-oiling bearings and the wheel head is provided with tapered sleeve bearings which can be adjusted to compensate for wear. The wheel head is moved up to the work by means of a pilot wheel which operates a rack and pinion, and an adjustable stop is provided to prevent the wheel from being fed too far forward. Cross feed of the wheel head is provided by means of a handwheel which operates the usual form of feed-screw. The base of the machine forms a reser-



Bridgeport No. 28 Face Grinder equipped with Rotary Magnetic Chuck

voir for holding water and a centrifugal pump delivers the water to the wheel.

The principal dimensions of the machine are as follows: Height from floor to center of spindle, 42 inches; size of front bearing on work head, 7 inches long by 2½ inches in diameter; size of rear bearing on work head, 6 inches long by 2 inches in diameter; size of front bearing on wheel head, 4½ inches long by 2½ inches in diameter; size of rear bearing on wheel head, 3½ inches long by 2 inches in diameter; height from ways to center of spindle, 12 inches; diameter of magnetic chucks which can be used, 10 to 14 inches; size of cup-wheel, 9 by 5 by 1 inch; size of driving pulley on work head 12 by 3 inches; size of driving pulley on wheel head, 3½ by 5 inches; and weight of machine 2450 pounds.

BROWN & SHARPE MACHINISTS' SMALL TOOLS

The machinists' small tools shown in the accompanying illustrations are recent additions to the line of the Brown & Sharpe Mfg. Co., Providence, R. I. The "Rex" 1-inch micrometer shown in Fig. 1 was developed to meet the demand for an inexpensive precision measuring tool. The frame is a drop-forging shaped to give the maximum of strength and rigidity, without being too heavy. An improvement claimed for this caliper is the manner of placing

the graduations on the hub above the measuring line for 0, 50, 100, 150, etc., and below the line for 25, 75, 125, etc. This facilitates reading the caliper. The principle will be readily understood by referring to the illustration where the graduations are clearly shown. All bearing parts and measuring surfaces are hardened and means are provided for compensating for wear of the screw and anvil. This tool is also made for metric readings from 0 to 25 millimeters.

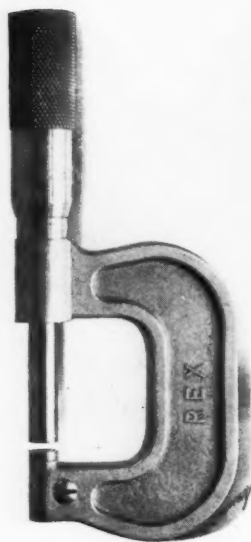


Fig. 1. "Rex" 1-inch Micrometer

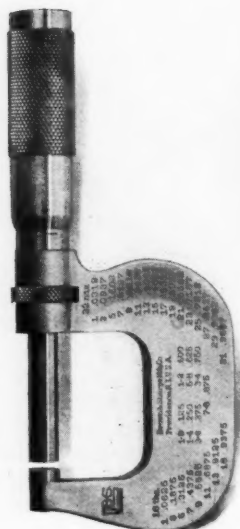


Fig. 2. B. & S. No. 12 Micrometer



Fig. 3. B. & S. Hub Micrometer

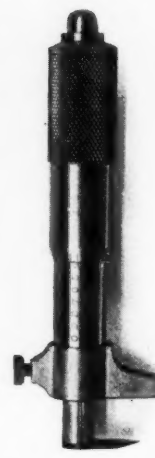


Fig. 4. Gear-tooth Depth Micrometer

The No. 12 micrometer caliper shown in Fig. 2 has the end of the frame tapered to allow it to be used in places where the ordinary type of micrometer will not enter. The thickness of the anvil is only 11/32 inch, but the frame is of a form which gives adequate stiffness to resist any tendency for the frame to spring. The graduations on the hub alter-

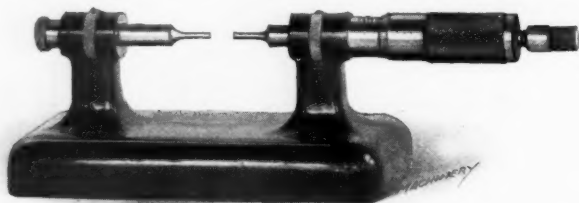


Fig. 5. B. & S. 1-inch Bench Micrometer

nate above and below the measuring line, as in the case of the "Rex" micrometer shown in Fig. 1. A clamping nut is provided to clamp the spindle when it is desired to maintain a fixed setting. This caliper is made with a range of 0 to 1 inch and 0 to 25 millimeters.

Another small tool which has been brought out by the Brown & Sharpe Mfg. Co. consists of the micrometer caliper shown in Fig. 3 which is used for measuring the exact length of hubs of cutters, the thickness of saws, etc. Fig. 4 shows a micrometer for measuring the depth of gear teeth which does away with the necessity of employing a large number of separate gages for this purpose. In Fig. 5 a 1-inch bench micrometer is shown, this tool being provided with a heavy base. It is intended for the use of toolmakers, jewelers, etc.



Fig. 6. V-thread Gage for 4 to 84 Threads per Inch

Fig. 6 shows an improved screw pitch gage for V-thread screws and nuts. This gage has a range of 51 pitches—from 4 to 84 threads per inch. This unusual number of pitches is made possible by the triangular form of the frame which serves as a very compact housing for the blades.

The dial test indicator shown in Fig. 7 is for the use of toolmakers, inspectors, and others who have frequent use for a tool of this nature. The base is

sufficiently heavy to afford a firm support for the instrument, and four gage pins are placed at the corners of the base, which can be pushed down when it is desired to use the indicator against the side of a plate, straightedge, or in a T-slot. The dial is made to read to 0.001 inch or 0.01 millimeter and is adjustable to enable the gage to be set to read zero in any desired position. The Brown & Sharpe Mfg. Co. has also recently brought out a steel music wire gage to conform with the American Steel & Wire Co.'s new standard. This gage is of the usual round type and has a range of

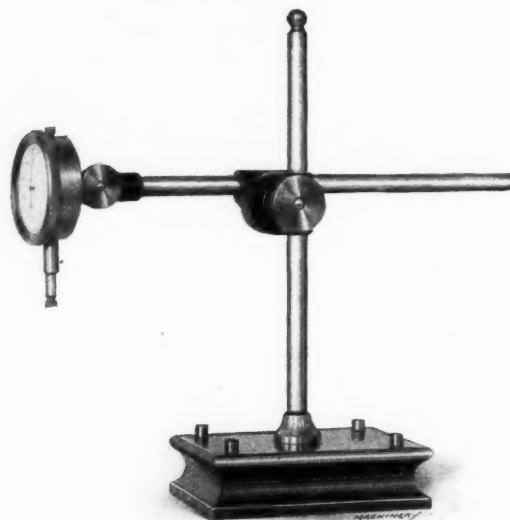


Fig. 7. B. & S. Dial Test Indicator and Stand

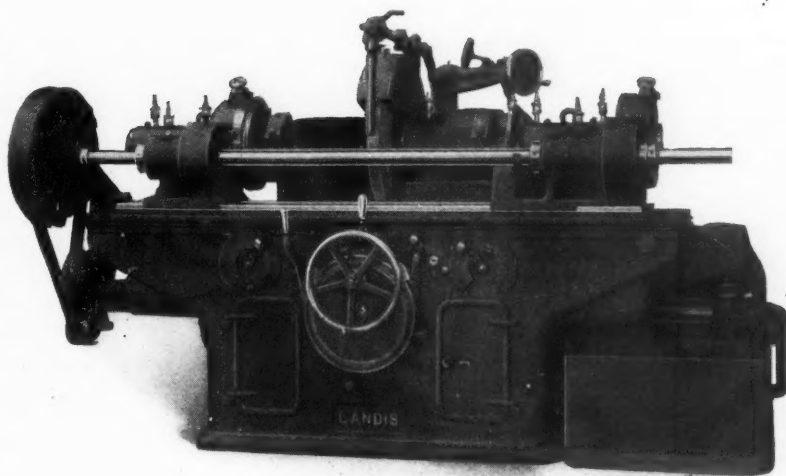
numbers from 000000 to 33. Decimal equivalents of the numbers are stamped on the reverse side of the gage.

LANDIS CRANK GRINDER

The Landis fixed-throw crank grinder, which is illustrated and described herewith, is a recent product of the Landis Tool Co., Waynesboro, Pa. The heads of this machine are designed to provide for the rapid handling of crankshafts while grinding the pins, and in handling this work it is unnecessary to index the heads or take the crankshaft out of the machine until it is completely finished. The cranks are fixed in position by means of a locating pin which enters a hole in the flange on the crankshaft. The hole is drilled central with the pins and is ultimately used when clamping the flywheel to the crankshaft. The heads on this machine will accommodate both single- and double-throw crankshafts and are particularly adapted for shafts having a flange.

The throw of the machine can be changed by having other

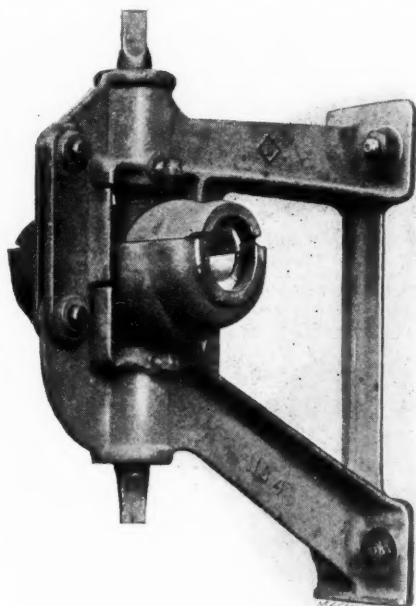
crankshaft carrying fixtures, such fixtures being provided for handling double-throw crankshafts up to 6 inches and single-throw crankshafts up to 8 inches. When grinding double-throw shafts it is only necessary to loosen the clamping bolts in the fixture and turn the crankshaft around to provide for grinding the other throws. The design of the heads allows the wheel to be worn down to a smaller diameter than is ordinarily possible; although it will, of course, be understood that the wheel cannot be entirely used up in grinding pins. The wheel can be worn down to a much smaller diameter in grinding the line bearings.



Landis Fixed-throw Crank Grinder

DODGE ADJUSTABLE BRACKET HANGERS

The accompanying illustration shows an adjustable ball and socket bracket hanger which has recently been placed on the market by the Dodge Mfg. Co., Mishawaka, Ind. These brackets are used in cases where it is necessary to support a lineshaft directly from the wall of a building and have it at a sufficient distance from the wall to enable the required size of pulleys to be used. The hangers are made in eight different sizes with capacities for supporting shafts ranging from 1 3/16 to 1 15/16 inch in diameter, and with extensions from the



Dodge Adjustable Ball and Socket Bracket Hanger

wall to the center of the shaft of 12 and 18 inches. The brackets may be equipped with either standard, capillary-oiling or ring-oiling bearings.

COLTON FILING MACHINE

The Arthur Colton Co., Detroit, Mich., is now manufacturing the filing machine shown in the accompanying illustration. The file is held by a collet in the upper end of the spindle which is tightened by turning a hand nut at the lower end of the spindle. In order to change files or change the position of a file, it is merely necessary to turn the hand nut through one-half revolution, no tools being required for this purpose. All working parts of the machine are carefully protected from damage which would result through having filings or dust find their way into the mechanism.

The bearings are bushed and made interchangeable so that they may be readily renewed. The spindle is hardened and ground, and the reciprocating parts are counterbalanced to insure smooth running of the machine. The usual form of tilting table provides for filing the clearance in dies or other beveled work and the table is equipped with a removable disk

to allow larger sized files to be used. The principal dimensions of the machine are as follows: diameter of table, 9 1/2 inches; stroke of machine, 1 1/2 inch; height to top of table, 43 inches; floor space occupied, 18 by 20 inches; and net weight of machine and counter-shaft, 135 pounds.

HJORTH ADJUSTABLE REAMERS

The Hjorth Lathe & Tool Co., 101 Tremont St., Boston, Mass., is

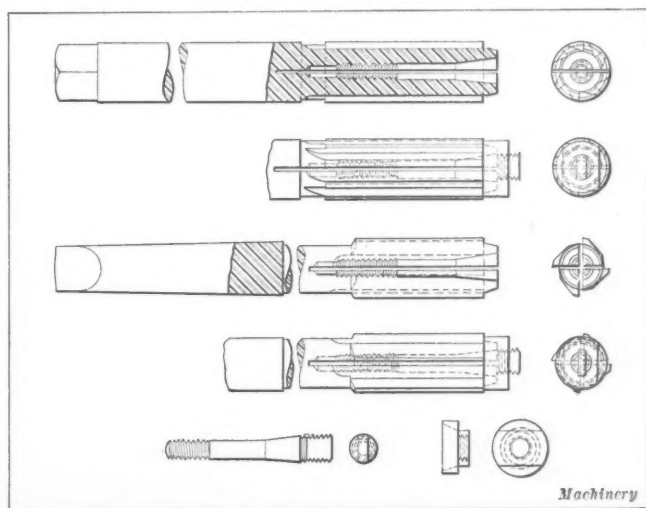


Colton Filing Machine

now manufacturing a line of adjustable hand and machine reamers. These tools are made with Morse taper shanks or with straight shanks. The adjustment is readily made by turning a single stud with a tapered shoulder which expands the reamer blades. When the adjustment has been made, the stud is secured in place by a lock-nut. The expansion comes at the front end of the reamer, giving clearance for the full length of the fluted body which prevents the reamer from binding. Reference to the illustration will show that the reamer consists of three essential parts, i. e., the body, adjusting stud and lock-nut. The adjusting stud and lock-nut are milled on the sides so that all adjustments may be made with an ordinary wrench. These reamers are made in forty-nine different sizes ranging from 1/4 to 2 inches in diameter.

GOULD & EBERHARDT TURRET-TYPE RING GEAR ROUGHING MACHINE

Among the many interesting special machines at work in the plant of the Ford Motor Co. is the turret-type bevel ring gear roughing machine shown in Fig. 1, which is built by Gould & Eberhardt, Newark, N. J. Reference to the ac-



Hjorth Adjustable Reamers with Straight and Taper Shanks

companying illustrations will show that this machine contains many interesting features in design and construction. One of the chief points of interest is the octagon turret to which twenty-four bevel ring gears are clamped. This turret rotates continuously, and is provided with a gear mechanism for changing the speed of rotation. The turret rotates slowly while the cutters are at work on the ring gear blanks, and about seven times as fast between cutting positions, or when passing from one side of the ring gear to the other. Reference to the diagram, Fig. 2, will show that the cutter passes straight across the front of the ring gear, and consequently cuts a groove first in one side of the blank and as the turret rotates further around cuts a groove in the opposite side, this method of cutting continuing on all of the gears that are clamped to the turret. Once during each complete rotation of the octagon turret, the gear blanks are all indexed one tooth. It will also be noted that two teeth are cut in each gear at one pass of the cutters, or in other words, 48 teeth are roughed out at each complete turret rotation.

The cutter spindle carries three cutters corresponding to the three rows of gear blanks fastened to the face of the turret. It is therefore obvious that the cutters are working on three gears at the same time. The cutter spindle, as well as the turret rotating mechanism, is driven from a single

seen that two teeth in the gear blank have been completed; at *B* six; at *C* ten; at *D* twelve; and at *E* fourteen; whereas, the teeth in the gear at *F* are completely roughed out and the gear is ready to be removed from the turret.

The ring gears cut on this machine are 8 inches pitch

diameter, have forty teeth, 5 pitch, 1-inch face width, and are made from vanadium steel drop-forgings. The gashing cutters are 5½ inches in diameter, and run at 140 surface feet per minute. They work on the arc of a circle and leave, approximately 0.010 inch of material to be removed from the sides of the teeth in the gear planer. When the cutters are working, the turret is rotating at a speed of from 15 to 16 inches per minute, and about 112 inches per minute when passing from one side of the gear to the other. One operator can attend to two machines and the product of each machine varies from 180 to 240 gears in eight hours, or in other words, one gear is turned out complete every 2 2/3 to 2 minutes.

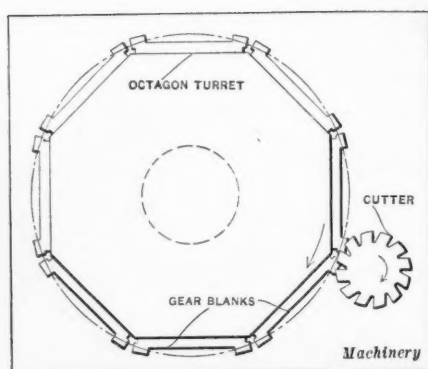


Fig. 2. Diagram showing Octagon Turret and how Ring Gears are presented to Cutter

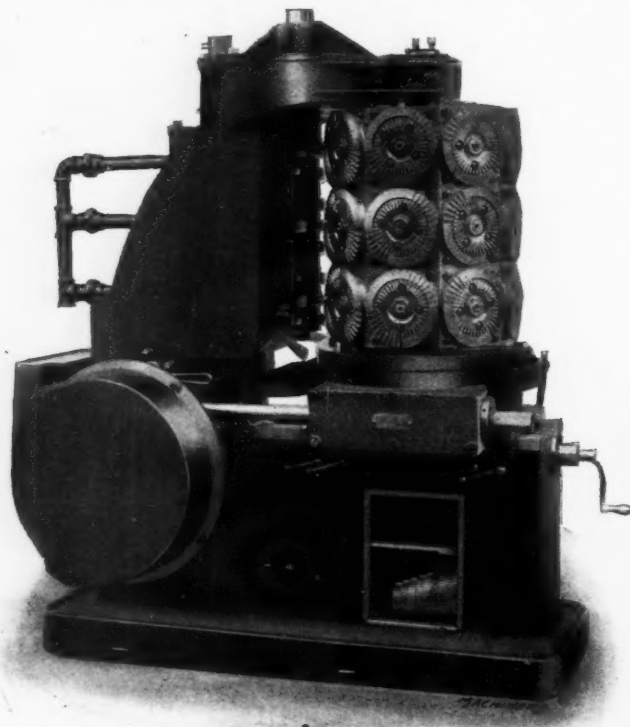


Fig. 1. Gould & Eberhardt Special Turret-type Bevel Gear Roughing Machine for roughing out Automobile Bevel Ring Gears

pulley, a change gear mechanism being interposed to get the correct speed for the cutter spindle and the rotation of the turret. The indexing mechanism for the individual dividing heads of work-holding plates also receives power from the same source.

The method of operating this machine is as follows: The operator first places one gear blank in position, clamping it by a single nut and plate washer. The machine is then started and one of the cutters starts to work on this first gear. Another gear is then placed on the turret while it is working, and this is continued until the turret is completely loaded. About the time that the turret is completely loaded, one gear is, as a rule, completely cut and ready to be removed. This is then replaced by an uncut blank and the process of loading and unloading continues. By following this method of operating the machine, it is not necessary to stop it at all to load and unload, and the machine is cutting practically all the time. Of course, when the machine first starts up it is not working on three gear blanks, but when the turret has been filled up, no cutter is idle. Fig. 3 shows very clearly just how this sequence of cutting progresses. At *A* it will be

FLATHER AUTOMATIC GEAR-CUTTER

The No. 2 automatic gear-cutting machine for spur and bevel gears, which is illustrated and described herewith, has recently been placed on the market by the E. J. Flather Mfg. Co., Nashua, N. H. This machine is provided with eight changes of speed and twelve changes of feed. The cutter carriage can be adjusted to any angle up to 90 degrees and graduations are provided which indicate the angle of eleva-

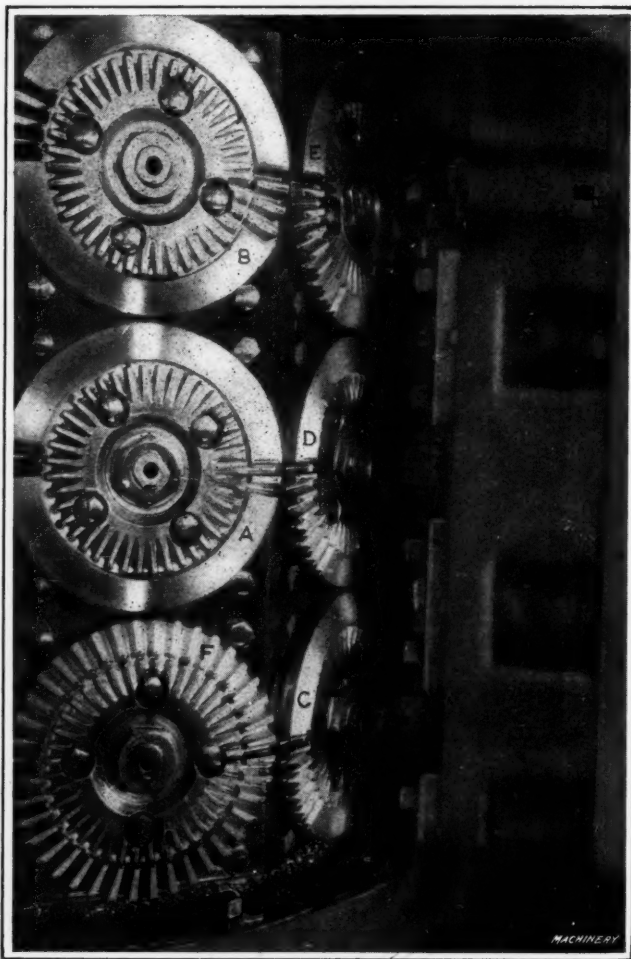
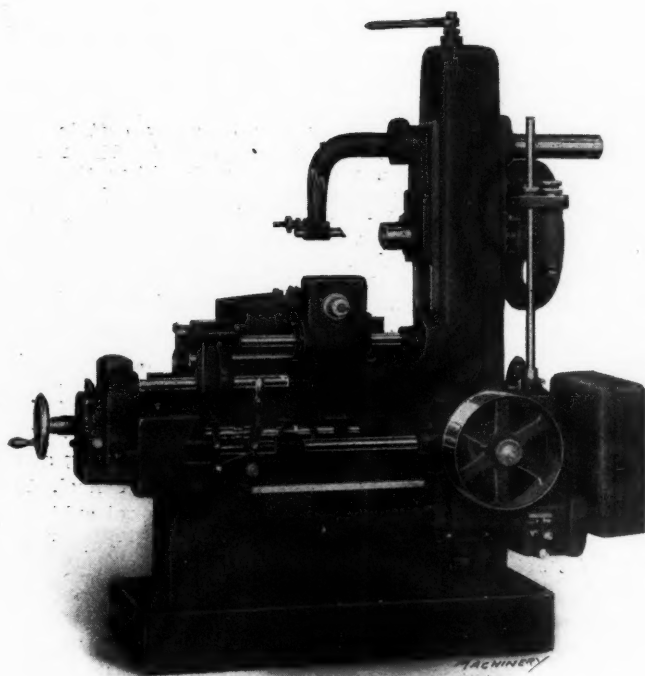


Fig. 3. Close View of Octagon Turret showing Progressive Cutting of Teeth on Ring Gears as Turret rotates



Flather No. 2 Automatic Gear-cutting Machine

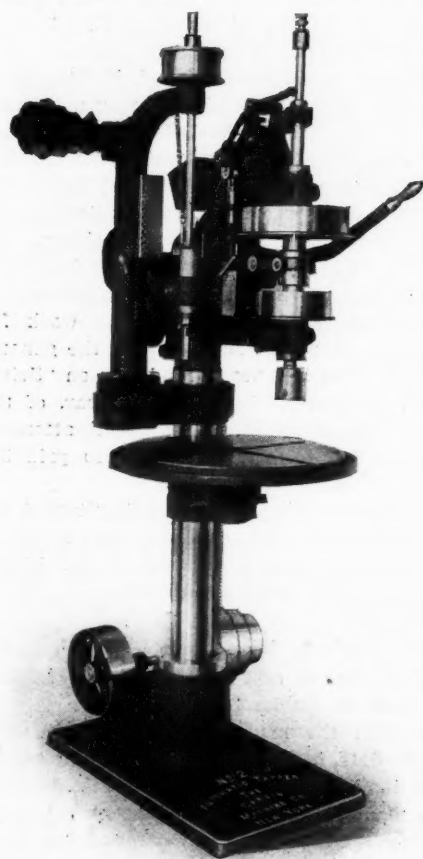
tion. Sidewise adjustment is provided for the cutter to permit of cutting bevel gears. The cutter is returned at a rapid and constant speed which is independent of the speed or feed at which it is working. The elevating screw is mounted on ball bearings and operated by a handwheel which is provided with a dial graduated to 0.001 inch.

The index mechanism operates at constant speed and index change gears are provided for cutting all numbers of teeth from 12 to 100 inclusive and from 100 to 400 with the exception of prime numbers and their multiples. The equipment consists of a cutter centering indicator, change gears, wrenches, countershaft, oil pump and fittings, and change gear tables. The principal dimensions of the machine are as follows:

Capacity for cutting gears up to 24 inches in diameter by 8 inches face width, with teeth up to 5 diametral pitch; diameter of cutter arbor, $\frac{7}{8}$ inch, hole in front end of work-spindle, No. 12 B. & S. taper; diameter of hole through spindle, 1 inch; and weight, about 2500 pounds.

DRILLING AND TAPPING MACHINE

The combination drilling and automatic tapping machine, illustrated herewith, is a recent product of the Garvin Machine Co., Spring and Varick Sts., New York City. The machine consists of the Garvin No. 2 automatic tapping



Garvin Combination Drilling and Automatic Tapping Machine

machine on which the drill head is mounted and driven by an independent countershaft. The drill head has a capacity for driving drills up to $\frac{1}{2}$ inch in diameter and the tapping machine will drive U. S. S. taps from $\frac{1}{4}$ to $\frac{3}{4}$ inch in size in cast iron. The action of the tapping machine is automatic after the tap has been started. It will be evident that this machine enables work to be drilled and tapped without requiring it to be moved from one machine to another; hence a reduction of machining time is effected.

NEW MACHINERY AND TOOLS NOTES

Compressed Air Meter: New Jersey Meter Co., Plainfield, N. J. A compressed air meter known as the "tool-ometer" which is suitable for measuring the amount of air used by pneumatic tools.

Welding Outfit: Searchlight Co., Chicago, Ill. An oxy-acetylene welding outfit adapted to meet the requirements of the average machine shop. The torch is provided with seven interchangeable tips.

Electric Hoist: Link-Belt Co., Chicago, Ill. This hoist was designed for use in places where there is very little head room, permitting it to be used in locations where only a hand-chain block can be employed.

Punch Press Air Compressor: Benjamin Electric Mfg. Co., Chicago, Ill. A small air compressor for use on punch presses where compressed air is employed to eject the work from the dies or blow away dust and scale.

Portable Hydraulic Forcing Press: Metalwood Mfg. Co., Detroit, Mich. A portable hydraulic press which has a capacity of 8000 pounds pressure per square inch. The press is made in various sizes with capacities from 60 to 400 tons.

Milling Attachment: Hoenig's Machine Works, East Liverpool, Ohio. This attachment is adapted for use on lathes swinging from 12 to 24 inches. The attachment is supported by the regular toolpost and the cutter is driven by the head-stock spindle.

Curved Blade Grinding Attachment: Stockbridge Machine Co., Worcester, Mass. An attachment for use in connection with the "quick sharp" grinding machine of this company's manufacture, which adapts it for grinding tapered or curved machine knives.

Tapping Attachment: F. Wiard, Detroit, Mich. A tapping attachment adapted for operation in either a horizontal or vertical position. The chuck collet is of the floating type which prevents the breakage of taps and provides for obtaining an evenly finished thread.

Small Slotting Machine: Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. A 5-inch stroke slotting machine especially designed for use in finishing the breech mechanism on army rifles. The machine is also adapted for a variety of tool-room work.

Forge: Monarch Engineering & Mfg. Co., Baltimore, Md. A forge for heating tool steel and drill rod, which burns oil or gas. The forge may be operated on any desired air pressure and is intended to meet the requirements of mines and smelters, in addition to its use in manufacturing plants.

Pneumatic Riveting Hammer: Hanna Engineering Works, 2059 Elston Ave., Chicago, Ill. A 100-ton pneumatic riveter which has a reach of 48 inches and a 24-inch gap. The machines are furnished with air cylinders having a piston stroke of 22 inches and a 6-inch travel of the riveting die.

Forcing Presses: Atlas Press Co., Kalamazoo, Mich. One of these is a press especially designed for use on the bench or lathe, although it can be equipped with pedestal legs. A pressure of 12 tons may be obtained. The other press has capacity of 15 tons and is mounted on the usual form of pedestal.

Transfer Trucks: George P. Clark Co., Windsor Locks, Conn. These trucks are of the type used in connection with small elevated skids or platforms upon which the work is placed. One truck has a capacity for a maximum load of 2200 pounds. The other truck has a capacity for loads ranging from 500 to 1000 pounds.

Bench Drills: Millers Falls Co., Millers Falls, Mass. Two types of bench drills. On the first, quick change of speed is obtained by shifting a knurled barrel between the gears, and the feed is obtained by hand. The second machine is similar to the first, except that the feed is obtained by raising the table with a ratchet lever.

Sensitive Drill: Cincinnati Pulley Machinery Co., Cincinnati, Ohio. A machine known as the "Avey" No. $\frac{1}{2}$ drilling machine, which is made in either the bench or column type, and in combinations of from one to six spindles. Spindle speeds up to 12,000 R. P. M. are available and the machines take drills up to $\frac{3}{4}$ inch.

Cutting-off and Centering Machine: Etna Machine Co., Toledo, Ohio. This machine was formerly made by the

Holton Co., and is now manufactured in a somewhat altered design by the Etna Machine Co. In its original form, the machine was illustrated and described in the September, 1913, number of MACHINERY.

Shrapnel Shell Painting Machine: Canadian Fairbanks Morse Co., Toronto, Ontario, Canada. A portable machine for use in applying the rust-proof paint to shrapnel shells to meet the requirements of government specifications. With this machine it is possible to apply three coats of paint to a shell in less than one minute.

Blueprinting Machine: Wickes Bros., Saginaw, Mich. A continuous electric blueprinting machine which is of simple and compact design, and easy to operate. The contact between the tracing and the paper is secured by a single continuous belt that passes around the feed rolls to the printing cylinder in which the light is located.

Time Study Watch: M. J. Silverberg, Peoples Gas Bldg., Chicago, Ill. A direct reading time study watch with a dial which shows the usual decimal divisions of a minute, and also figures which indicate the computed output per hour from single operations performed in respective intervals of time marked by corresponding graduations.

Hydraulic Bulldozer: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. This bulldozer may be operated from either an accumulator or pump, the pressure being controlled by a double-acting poppet valve. The table is 24 by 48 inches in size; the ram is 12 inches in diameter and has a stroke of 12 inches. The capacity is 150 tons.

High-speed Hacksaw Machine: West Haven Mfg. Co., New Haven, Conn. A machine equipped with a hydraulic oil ram which performs four functions, i.e., it lifts the saw off the work on the return stroke, raises the frame to any height, lowers the frame and holds it in any required position. The machine is equipped with a double removable vise.

Hydraulic Wheel Press: Chambersburg Engineering Co., Chambersburg, Pa. This is said to be one of the largest hydraulic wheel presses which has ever been built, the claim being based not only on its weight, but on the distance between tie bars, the maximum opening, and the speed of operation. The design follows closely along established lines.

Quick-acting Wrench: Automatic Wrench Mfg. Co., Boston, Mass. A wrench provided with means for instantaneous adjustment by simply placing the object to be turned between the jaws, then pushing a thumb trigger and pressing the movable jaw up against it. With the movable jaw in position, the grip is maintained by an automatic locking clutch.

Oxy-acetylene Welding Outfit: Imperial Brass Mfg. Co., 12-14 West Harrison St., Chicago, Ill. A welding apparatus in which the oxygen passes at high velocity through a spiral groove that imparts a whirling motion to it before entering the mixing chamber. This is said to cause the oxygen to mix more thoroughly with the acetylene before the gases reach the combustion point.

Friction Clutch: Conway & Co., Cincinnati, Ohio. A friction clutch of unusually simple design which consists of three principal parts, viz., the pulley or drum, the expansion member and the cone. A wide range of adjustment is provided on this clutch and it is adapted for use on all kinds of machine tools, countershafts and special machinery. The clutch is made in all sizes up to 12 inches.

Electric Welding Machines: Agnew Electric Welder Co., Detroit, Mich. A No. 10-D and a No. 20-D spot welding machine and a No. 20-C butt welding machine have recently been placed on the market by this company. Important features of both types of machines are that the working points are water-cooled; and that the high tension wires are enclosed so that accidental contact with them is impossible.

Recording Pyrometer: Wilson-Maeulen Co., 1 E. 42nd St., New York City. A pyrometer known as the "Tapalog." The special feature of this instrument is that the carriage carrying the chart, ribbon and other parts of the recording mechanism is pivoted to drop away from the galvanometer when it is required to change the chart. This obviates the danger of damaging the galvanometer. The record is made on the under side of the chart.

Portable Electric Grinder: Hissey-Wolf Machine Co., Cincinnati, Ohio. A portable electric toolpost grinder which is made in a variety of styles and sizes for operation on both direct and alternating current. By simply loosening two screws at the commutator end of the motor, the cap can be removed to give access to the brushes, brush-holders and electrical connections. The direction of rotation can be instantly changed by reversing the two lead wires.

Vertical Spindle Surface Grinder: Blanchard Machine Co., 64 State St., Cambridge, Mass. On this machine an individual driving motor is provided and the use of a driving belt has been eliminated, the essential parts of a standard motor being incorporated in the wheel head in such a manner that they are protected from the detrimental effect of moist-

ure or dirt. Thorough ventilation is provided. In this way, the power is applied direct to the spindle which carries the abrasive wheel, providing a very efficient drive.

Improved Features of Lathe Design: Greaves-Klusman Tool Co., Cincinnati, Ohio. On the lathes of from 16 to 30 inches swing manufactured by this company certain noteworthy improvements have been incorporated. The 20-, 22-, 24- and 30-inch lathes are equipped with either three-step cone and double back gears or with an all-gear head. The spindle nose of the 16-, 18-, 20-, and of the 22-, 24-, and 30-inch sizes are made in standard sizes so that faceplates and chucks are interchangeable. The apron has the mechanism mounted in the back plate with bushings in the front plate acting merely as supports. The beds are heavily webbed to provide greater rigidity.

* * *

NEW HAVEN MEETING OF THE A. S. M. E.

The New Haven branch of the American Society of Mechanical Engineers held its regular spring meeting at the Mason Laboratory of the Sheffield Scientific School, Yale University, on Wednesday, April 21. The general subject of the meeting was "The Development of Machine Tools." The meeting was well attended and very successful. Two sessions were held, one in the afternoon and one in the evening. Three papers were read at each session.

At the afternoon meeting, at which Prof. Lester P. Breckenridge presided, the first paper, read by Prof. Joseph W. Roe of the Sheffield Scientific School, dealt with the "Early History of Machine Tools." In a brief, but comprehensive review, the history of machine tools was traced from the early English pioneers down to the New England machine tool builders in the earlier half of the past century. L. D. Burlingame's paper on "Modern Developments in Milling Machines," reviewed the history of this type of machine, as developed by the Brown & Sharpe Mfg. Co., Providence, R. I., and showed briefly its universal application. A. L. DeLeeuw, of the Singer Mfg. Co., Elizabethport, N. J., read a paper on "Milling Cutters and Cutting Tools," in which he briefly outlined the remarkable results obtained by the use of helical milling cutters and circular rotating lathe tools—the latter a radical development which is likely to have far-reaching effects when machines adapted for the use of these tools have been developed. Cutting speeds of over 650 feet per minute have been successfully obtained by this type of tool in turning steel or cast iron.

At the evening meeting, presided over by H. B. Sargent, a paper on "Modern Development in Vertical Boring and Turning Machines" was read by E. P. Bullard, Jr., of the Bullard Machine Tool Co., Bridgeport, Conn., in which the development of this type of machine, from the earliest form of a "lathe placed on end," to its present highest development in the automatic vertical turning machine, was shown. D. DeLancey, of Waterbury, Conn., read a comprehensive paper reviewing a complete series of "Special Forms of Presses for Working Sheet Metal," calling attention to the work for which the different types were best adapted, and the general features of their design. The last paper read was on "Grinding as a Manufacturing Process," by H. W. Dunbar, of the Norton Grinding Co., Worcester, Mass. Especial attention was given in this paper to form-grinding and to grinding with wide wheels.

The papers were of unusual interest in that they traced the development of the various classes of machine tools from the earliest or simplest forms to the most modern and highly developed types. All the papers were illustrated by lantern slides.

* * *

The first record of the use of cast iron dates back to 1543 when a cannon was made in England from this material. It is believed, however, that the method of casting iron was known previous to this date, because in 1595 a cannon weighing 6000 pounds was made, and it is doubtful if such progress could have been made in fifty years. The first record of cooking utensils being made from cast iron is found 160 years after the first cannon was cast, so it seems that in those days armament led in the metallurgical field as it does to a great degree at the present time.

CONTINUOUS ROD-CASTING PROCESS

CONSTRUCTION AND OPERATION OF A CASTING MACHINE DESIGNED TO SIMPLIFY THE MANUFACTURE OF RODS AND WIRE

BY EDWARD K. HAMMOND*

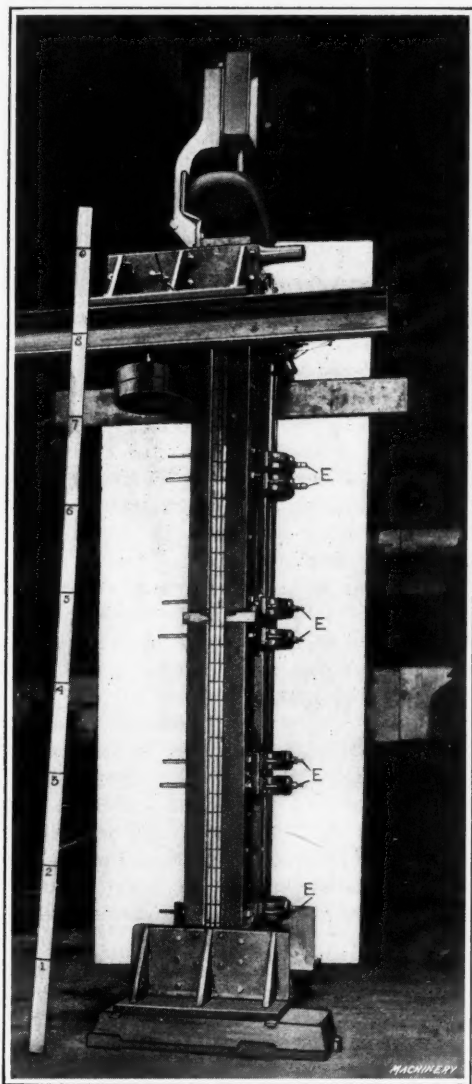


Fig. 1. Front View of Mellen Rod Casting Machine showing Idle Side of Chain of Mold Sections

tinuous mold formed by two sets of mold sections—each of which forms half of a continuous two-part mold—that are carried on two endless chains. The metal is carried along in this traveling mold and passed out in the form of a solid rod which can be carried on directly to the drawing dies. The mold sections run over sprockets and are returned to the starting point where the molten metal is being delivered into the mold. As long as the machine is kept running and supplied with molten metal a continuous rod will be produced.

The Construction of the Mold

Fig. 3 shows a close view of a portion of the chains of mold sections entering the top of the machine. Referring to this illustration it will be seen that the sections are machined with a semi-cylindrical groove *A* running longitudinally in them; and these two grooves come together to form the continuous cylindrical mold in which the rod is cast. It will also be noticed that at the end of each block forming the mold sections there is a slightly raised boss *B*. The surfaces of these bosses are accurately finished so that they fit tightly together, and the same is true of the faces of the mold sections in which the grooves forming the mold are machined. The necessity for this care in machining will be evident, as any opening in the joints would result in the casting of "fins" on the rod. The necessity for close fitting joints also made it desirable to adopt a special method of guiding the mold sec-

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IN the manufacture of rod and wire the usual practice is to cast the copper, brass, etc., into ingots which are first hammered and then rolled out into rods of a size which can be passed through the drawing dies. Perfectly satisfactory results—so far as the quality of the work produced in this way is concerned—are obtained by this method, but anyone who is familiar with the manufacture of rod and wire knows that it is an industry in which a large investment is required for equipment, and in which the labor and power cost is relatively high. With the view of reducing the investment in equipment and the cost of labor necessary to bring the metal into the form of rods that are ready for the drawing dies, the Continuous Casting Corporation, Kinney Bldg., Newark, N. J., is at present working on the development of a machine and process for the continuous casting of rods of brass, copper, aluminum, lead, zinc and soft metal alloys. This process is the invention of the company's president, Grenville Mellen. Through its use, a single operation converts the molten metal into rods that are ready to be drawn. The machine is provided with a receiver into which the molten metal is delivered from any suitable form of melting furnace. From this receiver it flows into a con-

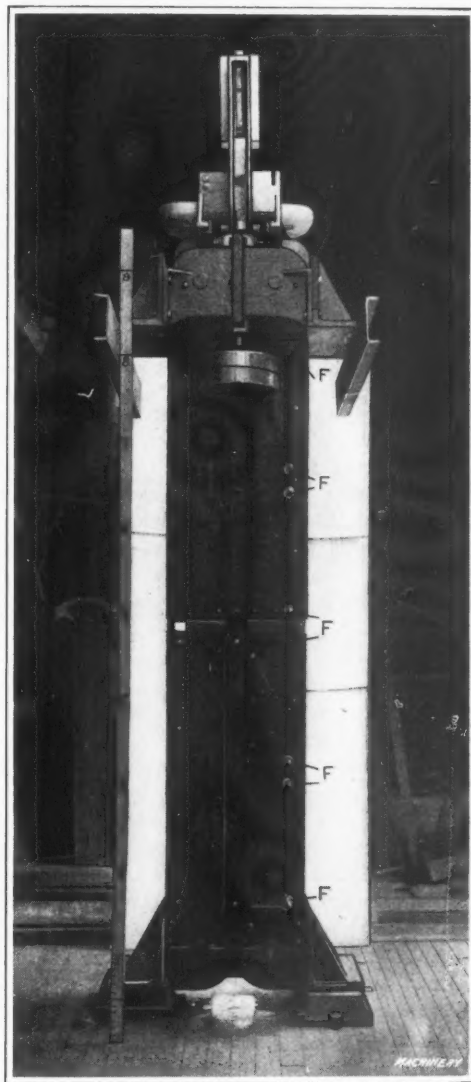


Fig. 2. Side View of Machine showing Arrangement of Drive and Means for adjusting Guide Bearings

tions into the machine. If these sections were simply carried over the ordinary form of chain sprockets, the ends of the sections would rub together and this would inevitably result in wear and consequently in loose joints. In order to overcome this difficulty a special form of cam guides is provided at the top of the frame of the machine. The rollers *C* which are carried by pins mounted in the mold sections, as shown in Fig. 3, run in these cam guides and result in rocking the mold sections in such a way that they move into the machine without the ends coming into contact until such a time as the bosses *B* at the ends of the sections are pressed together by the thrust of the sprockets over which the chains run.

Both the outer faces of the mold sections and the sides *D* are accurately machined to engage with guides which hold the sections in alignment while passing through the machine. Of the two guides which engage with the sides *D* of the mold sections, one is fixed and the other held in contact with the sections through spring pressure. The tension of the springs employed for this purpose may be adjusted by means of screws, this adjustment being made by regulating the nuts shown at *E* in Fig. 1. These guides are made in four sections because, as the molten metal solidifies, its temperature is reduced and the temperature of the mold sections is increased. As a result, the blocks expand and by having the guides in four sections instead of in a single piece, adjustment is automatically made for the difference in the size

of the sections. The pressure of the springs regulated by nuts *E* is supplied to the movable guides by means of pins which cause the movable guides to be pushed in against the mold sections, with the result that the sections are pressed against the fixed guide. A similar arrangement of one fixed and one movable guide engages the front and back faces of the traveling mold. In this case the tension of the springs which press the movable guides against the mold sections is regulated by means of screws *F*. These screws operate wedges which are moved so as to compress or release the springs for adjusting their tension to the required degree. Through the action of these two pairs of guides the sections are held in

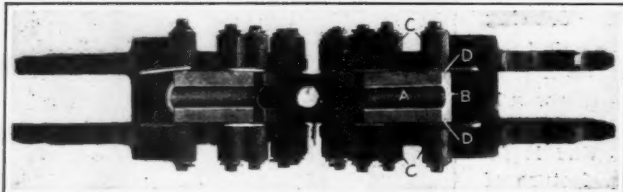


Fig. 3. Top View showing Mold Sections coming together to form Mold

proper alignment and the faces of each pair of sections are held in close contact with each other.

In addition, it is necessary to hold the ends of the sections in close contact. It will be evident from the preceding description of the guides that the alignment of the mold sections through the spring pressure applied to the guides will inevitably result in frictional resistance to the movement of the mold sections. This resistance is not of any great magnitude but it serves one very valuable purpose. The sprockets over which the chains of mold sections run exert a certain thrust which tends to move the chain forward. This movement is resisted by the friction of the mold sections in contact with the guides, and the result is that the ends of the sections are held in close contact with each other. In this way the possibility of metal leaking out of the mold through spaces between the ends of the sections is effectually eliminated. The sprockets which drive the chains of sections are located at the top of the machine and the shafts on which they are mounted are driven by two worm-wheels which engage with a common worm, this worm being driven by the tight and loose pulley arrangement shown in Fig. 2. A similar pair of sprockets at the bottom of the machine return the chains of mold sections, these sprockets being merely idlers over which the chains run.

Fig. 4 shows the mold in process of opening at the bottom of the machine, and a finished rod coming out. By referring to this illustration it will be seen that in spite of the precautions taken to hold the mold sections in accurate alignment and to keep the joints in close contact, the surface of the rod cast in the machine still shows lines which indicate that it was cast in a mold composed of sections. However, the marks of the sections left on the rod due to the joints in the mold are very slight, and these are "ironed" out by the passage of the rod through the drawing dies. It is said that the rods are of uniform structure and free from defects; and that the product drawn from these rods does not show any trace of these marks when it is finished.

In using this machine it will be evident that a great deal of heat must inevitably be given up to the mold sections in cooling the metal from the molten condition in which it is delivered to the machine, to a solid rod which is turned out at the lower end. This heat would soon result in the destruction of the mold were not some special means provided for dissipating it. The provision made for keeping the machine cool consists of having a series of jets which spray water onto the mold sections. The water is not turned on until the molds have reached a temperature sufficiently high to vaporize it, and as a result, the molds are perfectly dry at a distance a few inches above the uppermost jet. Where this method of cooling is used, no difficulty has been experienced from excessive heating of the mold and it has been found feasible to run the machine continuously. When casting $\frac{3}{8}$ -inch brass rods traveling at a speed of 42 feet per minute, with a distance of 8 feet between the centers of the sprockets

over which the mold sections run, it has been found that the temperature of the mold does not exceed 450 degrees F.

Factors which affect the Rate of Production

The rate at which rod can be produced in this machine is naturally dependent upon the speed with which the metal can be cooled from the molten state into rod which can be handled after it leaves the machine. Several factors affect this rate, the more important of which are the melting point of the metal which is being cast into rods, the temperature at which it is feasible to handle the metal after it leaves the machine, the specific heat of the metal in question, its specific gravity, and the size and cross-section of the rod. It will, of course, be evident that in operating the machine to cast metal with a high specific heat, it is necessary to run slower than would be the case with a metal of lower specific heat. This is due to the fact that the metal with a high specific heat is required to give out a greater amount of heat in order to cool it down to a point where it can safely leave the mold ready for subsequent handling. As the amount of surface of the mold sections exposed to the cooling water is constant, the variation of operating conditions to handle metals of different characteristics is obtained by varying the speed at which the machine is run. The statement made in regard to metals of different specific heats also holds good in the case of metals with high melting points or high specific gravity. If a machine is to be used constantly for one given class of metal which gives out an exceptionally large amount of heat while changing from the molten to the solid condition, provision may be made for increasing the rate of speed at which the machine is operated by increasing the height of the machine, so that there is a greater length of cooling water through which the mold sections pass before releasing their grip on the rod of metal.

An idea of the rate at which rod can be produced on this machine may be obtained from the fact that in tests which have been conducted it is stated that $\frac{3}{8}$ -inch copper rod was turned out at the rate of 26 feet per minute, while $\frac{5}{8}$ -inch aluminum rod was produced at the rate of 60 feet per minute. This difference in the rate of production is due to the difference in the melting point, specific heat and specific gravity of the two metals. For a ten-hour working day, the capacity of the machine is from 15 to 30 tons of rod.

How the Machine is Operated

Figs. 1 and 2 show two transverse channel irons near the top of the machine. In practice, these would be the beams

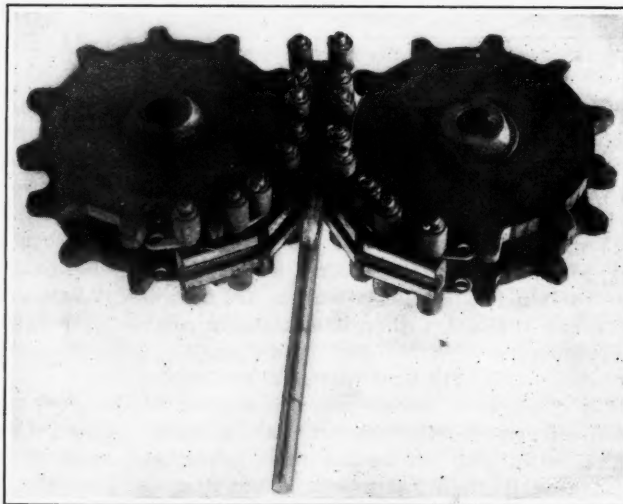


Fig. 4. Bottom View showing Mold Sections separating and Cast Rod leaving Machine

in the floor; and the receiver into which the molten metal from the melting furnaces is poured would thus be located in a convenient position for delivering this metal to the machine. The machine itself would extend through the floor so that the cast rod would be taken out on the floor below and delivered to the drawing machine. Details of the arrangement would, of course, be modified to meet the requirements of individual cases. The arrangement of the casting shop is shown diagrammatically in Fig. 5. Each ma-

chine has a capacity for the output of a battery of forty-one melting furnaces holding 220-pound crucibles, and six heats would be made in a ten-hour day. The receiver *A* on the machine into which the molten metal is poured has a capacity for 194 pounds of metal. This receiver is equipped with an automatic control device *B* which is actuated by a solenoid magnet connected to a battery circuit, one terminal of which is grounded on the machine and the other attached to a graphite valve projecting into the mold orifice. When the metal in the mold rises to contact with the graphite terminal, it closes the circuit and draws down the graphite valve to partially shut off the flow of metal into the mold. When the molten metal recedes from the terminal, the electric circuit is broken and the beam on which the terminal is carried swings up and opens the entrance to the mold to allow the metal to flow more freely.

It will, of course, be evident that the crucible *C*, from which the molten metal is being poured into the receiver on

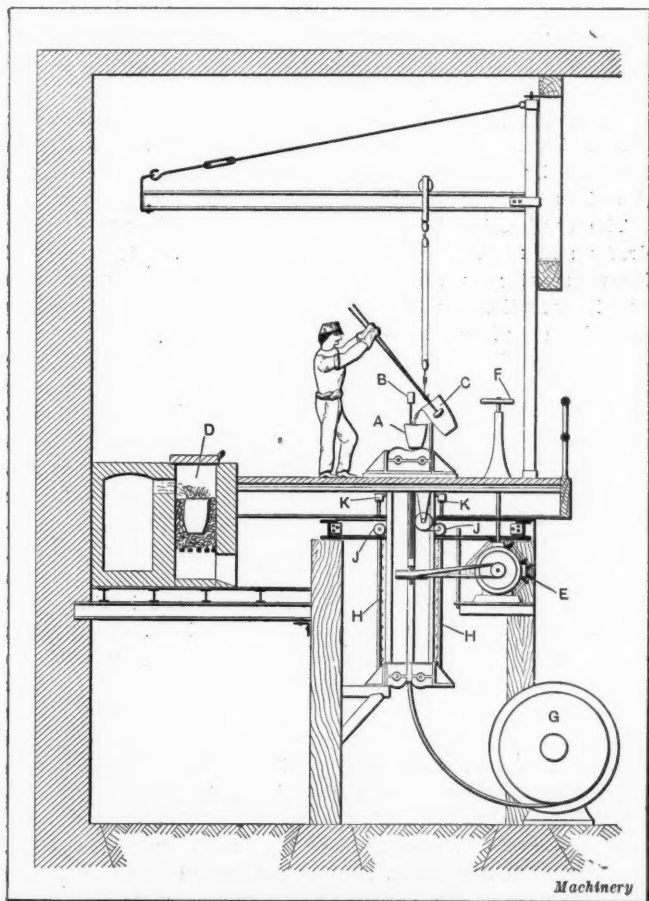


Fig. 5. Diagram showing Arrangement of Casting Shop equipped with Mellen Rod Casting Machine

the machine, has been carried over from the melting furnace *D*. The machine is driven by a variable speed motor *E* which regulates the speed according to the metal which is being cast, the regulation of the motor being controlled by the wheel *F*. A safety device is incorporated in the drive so that if any unusual condition arises, a safety pin will be sheared off and prevent damage being done to the mechanism. The rod as it leaves the machine is rolled up on a reel *G*. It has already been stated that the mold sections are cooled by water jets, and these are shown at *H* in Fig. 5. Mold-cleaning brushes *J* are located above the jets, these brushes being made of steel and employed to remove any deposit from the mold sections as they are returned to the top of the machine ready to come together again to receive a fresh supply of molten metal. A facing is applied to the mold sections by the air brushes *K* in order to prevent trouble from the metal sticking to the mold. It will be evident that in starting the machine the mold will have to be plugged up to hold the molten metal until it has time to solidify. At first a plug of metal was used, but experience has shown that a plug made of waste will retard the flow of metal through the mold sufficiently to give it time to solidify.

Advantages of the Mellen Process

It is not the purpose of this article in any way to exploit the Mellen process for casting metal rods, but as the chief merit lies in its ability to simplify the preliminary stages of rod and wire manufacture, a comparison of the work of casting rods in this machine, which has already been described, with that of producing rods by first casting ingots and then rolling them out, will prove instructive. The customary practice of rod and wire mills is to melt the metal and then cast it into ingots 3 to 5 inches square and from 4 to 6 feet in length. These ingots are then rolled out in the usual form of rolling mills, from ten to thirty passes being required to reduce the ingot to a $\frac{3}{8}$ -inch rod. Approximately thirty men would be needed to look after this work, and the rolling mill equipment used would consume a large amount of power. From 3 to 4 horsepower is required to drive the Mellen machine. It is unnecessary to call the attention of those familiar with rolling mill practice to the expense incident to the maintenance of the rolls or the amount of floor space required to handle the work, owing to the considerable length of the rod into which the ingot is rolled. The first cost and the expense of fuel and maintenance for furnaces used to heat the rods where rolling is employed is also avoided by the Mellen process. Another feature is that accidents which occur in the operation of rolling mills are avoided by having the rods cast in the machine where the hot metal is kept completely enclosed. Thus the Mellen process is a factor in the much talked of "Safety First" movement.

Another advantage of this method is the elimination of trouble due to oxidation. Where the metal is cast in ingots and then rolled out into rods which can be handled in the drawing dies, it is obviously necessary to heat the work for the rolling operations, and as the red-hot metal is in contact with the oxygen of the atmosphere, it is impossible to prevent this surface from becoming coated with a layer of oxide scale. As compared with this process, the rods cast by the continuous process have the molten metal delivered into an enclosed mold in which it solidifies out of contact with the air. The rod of metal emerging from the lower end of the machine has cooled down far enough so that the oxygen in the air will no longer affect it. When all of these facts are taken into consideration and compared with a method by which it is possible to cast the rods direct, using a machine of compact form which requires little power to drive it, it would seem that the Mellen process for the continuous production of rods should be one that will find wide application.

* * *

A great deal has been said of the origin of the safety movement, and it will interest manufacturers to know that the earliest record of systematic production is that of the Crane Co., Chicago, which in 1897 began to provide eye protectors for its men. In 1898 it put this work on a systematic basis, giving the glasses to the men free of charge and requiring operators as far as possible at that time to wear the glasses constantly when they were exposed to flying bits of metal, emery, dust and to the glare of hot metal. Dr. A. M. Harvey, who was at that time, and who still is, the company's chief surgeon, was the originator of this plan of providing glasses for the men. The fact that since the company has been providing glasses eye injuries to its employes have been cut down to an extremely low point, proved the value of having adequate eye protection for workmen in shops. Crane & Co. posted signs conspicuously in their plant drawing the attention of the men to the necessity of using glasses and the fact that the glasses were provided free of charge. The company is one of the best known industrial concerns in the safety movement, and much of its success is due to the thoroughness and activity of Dr. Harvey.

* * *

The reference on page 621 of the April number of MACHINERY on heat-treating shrapnel shells was incorrect. Instead of an oil bath for tempering, a muffle furnace heated to a temperature of 1000 degrees F. was used for drawing the temper of the shrapnel shells for a distance of about two-thirds of their length.

SURFACE COMBUSTION APPLIANCES

The combustion of gas without the admixture of oxygen is inefficient for heating; the ordinary fantail gas burner produces both light and heat, but as a means for heating it is very inefficient, while the Bunsen burner, in which gas and air are mixed before reaching the combustion zone, generates little light and much heat. The Welsbach mantle lamp is a Bunsen burner apparatus in which a highly refractory material is heated to incandescence to produce light. The mixture of air and gas required for perfect combustion is explosive and the ordinary Bunsen burner cannot be used with a perfect mixture as it back-fires and the flame snaps out. Hence, in all ordinary Bunsen burners it is necessary to supply an excess of air or gas in order to maintain continuous combustion.

A new development in gas burners for heating has been in process of development to which allusion in these columns has

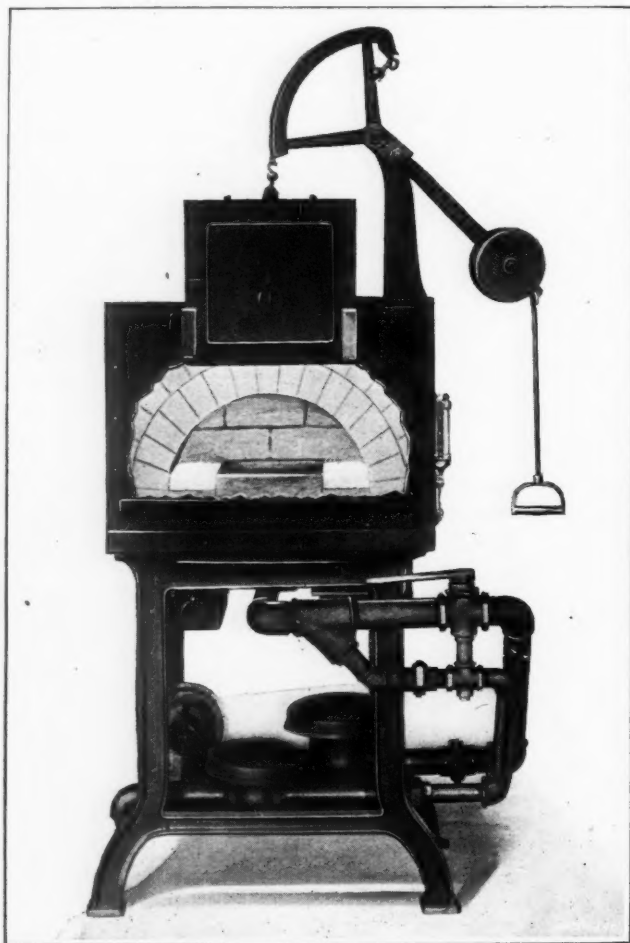


Fig. 1. Surface Combustion Gas Furnace for heat-treating Metals

previously been made. An article was published in the May, 1912, number on "Surface Combustion," describing experiments made by Prof. Bone of England, which had demonstrated that the efficiency of gas heating could be greatly increased if the combustible mixture was directed through a porous refractory medium like fire-brick or onto a bed of granulated refractory material. Dr. Charles E. Lucke of Columbia University had also experimented with surface combustion, and had taken out patents in America. The Bone and Lucke interests were combined, the American rights being vested with Dr. Lucke and his associates, while the British rights were similarly vested with Prof. Bone. This process of combustion is comparable with that of the Welsbach burner, but its object is to produce radiant heat instead of light.

The Surface Combustion Co., 148-150 W. 52d St., New York City, has acquired the rights under the Lucke and Bone patents for industrial applications. Fig. 1 shows a gas furnace of the surface combustion type, for which a saving of gas of fully 35 to 40 per cent over the ordinary types of equal capacity is claimed. The furnace comprises an ordinary fire-brick arch with channels at each side of the hearth in which

an artificial highly refractory, granular material is placed. The mixture of gas and air is supplied through these beds of granular material, having first entered the mixing chamber which communicates with the fuel beds above

through a large number of small metal pipes, each about $\frac{1}{8}$ inch diameter. The reason for feeding the fuel to the fuel bed through small pipes is to prevent back-firing. The combustion zone is thus fixed, and the combustible mixture neither blows off nor heats back.

The gas is supplied at ordinary city main pressure, equivalent to a head of about three to four inches of water. The air blast is delivered at an equal pressure, by a small blower driven by an electric motor. Suitable control apparatus actuated by diaphragms is furnished for both the air and gas pipes to insure balance of the fuel and air supplied.

The combustion is characterized by the absence of flame drafts and roar. The interior of the furnace is filled with incandescent gas; the heat, while intense, is very uniform and is exceptionally suitable for heating steel for hardening. The absence of drafts and local variations in temperature favors uniform heating and minimizes the trouble of distortion.

Fig. 2 shows the form of surface combustion apparatus recommended for melting pots, the shape being circular. It consists of a cast-iron cup lined with fire-brick and filled with refractory material. The mixing chamber forms the base and between the base and the bottom of the fuel bed are interposed numerous small pipes to feed the fuel to the fuel bed.

Fig. 3 shows another form of surface combustion "fire," this being rectangular in shape but otherwise of the same style as Fig. 2. The illustration is of a fire having a bed about eighteen inches wide and three feet long. Larger sizes can be made, but for very large sizes it is recommended that a number of comparatively small units be grouped. There is no limit to the size of a surface combustion fire, but for practical reasons they are preferably made in units of small size to facilitate manufacture and to save expense when making repairs.

Surface combustion fires can be run efficiently at temperatures in excess of 3000 degrees F. In fact, platinum which melts at 3191 degrees F. may be readily and rapidly melted. It is possible to consume efficiently a volume of gas equivalent in heating power to 150 pounds of coal per hour per square foot of fuel bed while not more than sixty to seventy pounds per square foot of grate area can be burned on locomotive

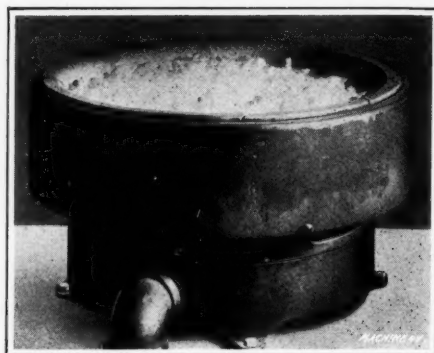


Fig. 2. Surface Combustion "Fire" for Melting Pots

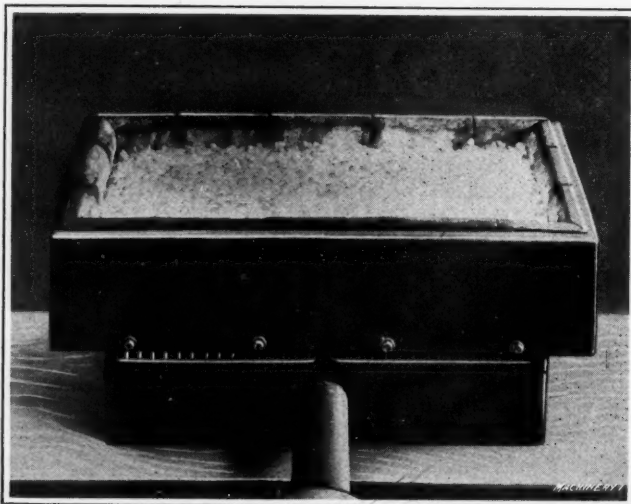


Fig. 3. Surface Combustion "Fire" Rectangular in Shape for Industrial Applications generally

boiler grates. This intensity of fuel consumption coupled with almost perfect combustion produce an intensely hot radiant fire. There being no excess of air, a minimum of heat is carried off in the waste gases. The possible applications of surface combustion are innumerable, but one of common interest that promises to increase the domestic use of gas is in gas stoves and heaters. It saves gas and improves cooking facilities greatly.

* * *

CONVENTION OF THE NATIONAL METAL TRADES ASSOCIATION

At the seventeenth annual convention of the National Metal Trades Association held at the Hotel Astor, New York City, April 14-15, there was a registered attendance of 194 members and guests. President Herbert H. Rice of the Waverly Co., Indianapolis, Ind., presided. The order of proceedings was as follows:

Wednesday Morning Session

The convention was called to order at 9:30 and an address of welcome was delivered by H. N. Covell, president of the New York and New Jersey branch. After the preliminary business of roll call, reading of minutes, and the appointment of convention committees on credentials, resolutions, constitution, auditing and convention had been attended to, President Herbert H. Rice read his report. Mr. Rice referred briefly to the objects which had led to the founding of the association and the work which had been accomplished through cooperative effort. He had no change of policy to advocate, but expressed his opinion that one of the most obvious lines of development which the association could undertake would be that of making further increases in membership. Next in order came the report of Treasurer F. C. Caldwell, which showed the financial status of the association to be very satisfactory.

The report of Commissioner John D. Hibbard pointed out that the fiscal year of 1914-15 had witnessed the development of two movements of marked importance to the National Metal Trades Association; first, the development of a method of procedure in conducting investigations by the Federal Commission on Industrial Relations; second, the closer affiliation and cooperation of national organizations of employers through conference boards. Mr. Hibbard referred very briefly to the investigations of the Federal Commission on Industrial Relations, and then went on to tell of the benefits accruing from the cooperation of national organizations of employers through the establishment of conference boards, explaining the results which could be accomplished through cooperative effort where the effort of the individual proved ineffective. Other general matters of interest to the association were touched upon, including the work of safety inspection. The final officer's report was that of Secretary H. D. Sayre.

The reports of standing committees included the following: Industrial Education, F. A. Geier, chairman, Cincinnati Milling Machine Co., Cincinnati, Ohio; Apprenticeship, W. A. Viall, chairman, Brown & Sharpe Mfg. Co., Providence, R. I.; Membership, John W. O'Leary, chairman, Arthur J. O'Leary & Son Co., Chicago, Ill.; and Publicity, Justus H. Schwacke, chairman, William Sellers & Co., Inc., Philadelphia, Pa.

In the report of the committee on industrial education some particularly interesting figures were quoted as to the relative earning capacity of industrial workers who had received vocational training before entering the factory in which they found employment and those who came unprepared. These figures were quoted from the bulletin of the National Association of Corporation Schools and are as follows: A comparison was made of fifty-one children who had received no preliminary training and fifty-one children who had received trade training, average age of both groups fourteen years. The average wage of the untrained children who had been working for six months was \$4.30 per week; that of the trained, \$6.85; the average wage of untrained children who had been working for one year was \$5.10 per week, and that of trained \$9.50 per week; of the untrained children who had been working for two years the average wage was

\$5.85, while that of the trained sixteen-year-old worker was \$10.84. These figures certainly make an excellent plea for industrial education from both an economic and humanitarian point of view.

In the report of the committee on apprenticeship, mention was made of the resolution passed at the annual meeting of the association in 1913 to employ a man to assist in the organization of apprenticeship systems in the shops of members of the National Metal Trades Association. It has been realized that a man competent to fill such a position satisfactorily must, of necessity, possess exceptional qualifications, and up to date a suitable appointee for this position has not been discovered. The committee called upon the members of the association to assist them in discovering a man suitable for this post. Reference was made to a meeting called by M. W. Alexander with the object of forming a conference board on the training of apprentices, and the committee expressed itself as of the opinion that such a board could accomplish very valuable work. The following resolution was placed before the convention: "Resolved that the National Metal Trades Association authorize the participation of a committee with the conference board on training of apprentices, and that the executive committee allow the necessary dues and the expenses of such a committee, provided said committee upon investigation approves the work of the conference board on training of apprentices." This resolution was passed.

During the interval between the morning and afternoon session a buffet luncheon was served.

Wednesday Afternoon Session

The Wednesday afternoon session was devoted to a report of the committee on prevention of industrial accidents, W. H. Van Dervoort, chairman, Root & Van Dervoort Engineering Co., East Moline, Ill., and a discussion of this report by William H. Doolittle, safety inspector of the National Metal Trades Association; a talk on "Cooperation Work of National Employers' Associations through Conference Boards," by Magnus W. Alexander, General Electric Co., West Lynn, Mass.; a talk entitled "State Legislation and the Business Man in Politics," by Dudley Taylor; and an illustrated talk entitled "Highways and Hedges of Many Managers of Men," by Walt. S. Goodwin.

The convention banquet was served at 7 P. M., the speakers of the evening being Frederick P. Fish of Boston, Mass., and Alfred W. Martin of New York City.

Thursday Session

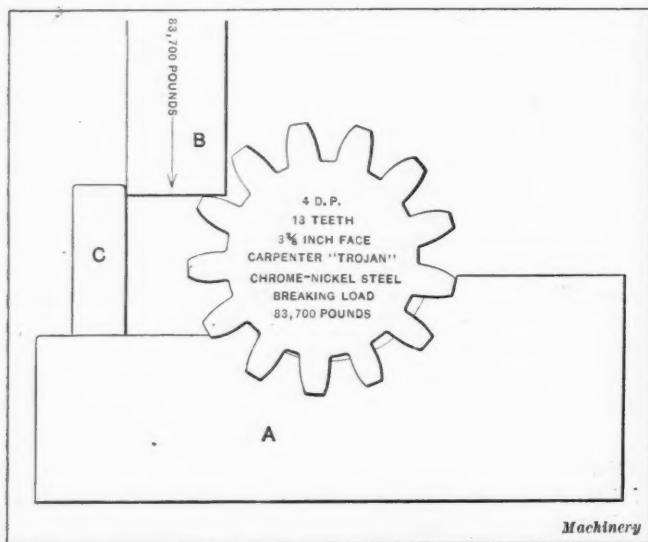
The Thursday session was devoted to an address by Daniel Davenport, explaining how the responsibility of members of trades unions for the acts of the officers of the union had been legally established; a paper by Walter Drew, National Erectors' Association, New York City, dealing with the work of the Federal Commission on Industrial Relations; the reports of convention committees; the report of the nominating committee, F. C. Caldwell, chairman, H. W. Caldwell & Son Co., Chicago, Ill., and the election and installation of officers. The following officers were elected for the forthcoming year: President, Herbert H. Rice, the Waverly Co., Indianapolis, Ind.; first vice-president, George Mesta, Mesta Machine Co., Pittsburg, Pa.; second vice-president, W. H. Van Dervoort, Root & Van Dervoort Engineering Co., East Moline, Ill.; treasurer, F. C. Caldwell, H. W. Caldwell & Son Co., Chicago, Ill. Counsellors: W. A. Layman, Wagner Electric Co., St. Louis, Mo.; Paul B. Kendig, Seneca Falls Mfg. Co., Seneca Falls, N. Y.; J. W. Higgins, Worcester Pressed Steel Co., Worcester, Mass.; M. B. McLauthlin, George T. McLauthlin Co., Boston, Mass.; Justus H. Schwacke, William Sellers & Co., Inc., Philadelphia, Pa.; and Henry D. Sharpe, Brown & Sharpe Mfg. Co., Providence, R. I.

* * *

A description of the Gorton universal engraving machine designed especially for engraving tire molds, appeared in the March number. An illustration of a chain tread rubber tire mold appeared in the article, which was erroneously designated as being for the "Goodyear" make of tire, whereas it was for the United States tread tire made by the Morgan & Wright Co. of Detroit, Mich.

TEST OF POWER FORCING PRESS PINION

The ram of the forcing press made by the Lucas Machine Tool Co., Cleveland, Ohio, has a rack cut in one side, and it is operated by a pinion engaging the rack. The pinion thus sustains the full load, which in the case of a fifteen-ton press may be 30,000 pounds—concentrated on one tooth. If made of the same material as the ram, the pinion would be considerably weaker than the rack, but the aim, of course, is to design the press so that all parts will be nearly equal in strength. The pinions are made of alloy steel heat-treated, and some tests recently made showed a high resistance to fracture.



Block used for testing a Steel Arbor Press Pinion to Destruction

The illustration shows a testing block A made from a piece of steel about eight inches long, four inches wide and three inches thick, planed to fit and support five teeth of a thirteen-tooth, four diametral pitch pinion—the size used on a fifteen-ton press. The face or width of the teeth is 3 3/8 inches. The test load was concentrated on one tooth by the thrust block B. The studs C are provided to give lateral support to the thrust block. The pinion that gave the best results in the tests was made from Carpenter "Trojan" crucible chrome-nickel steel, heat-treated and showing a hardness of 61 to 65 on the Shore scleroscope scale. The ultimate load causing failure was 83,700 pounds or nearly three times the full load capacity of the press for which it was designed.

TEST OF ARBOR PRESS PINION

Load in Pounds	Deflection in Inches	Load in Pounds	Deflection in Inches	Load in Pounds	Deflection in Inches
30,000	.....	50,000	0.002	67,500	0.006
32,500	.....	52,500	0.002	70,000	0.006†
35,000	0.001	55,000	0.002	72,500	.....
37,500	0.001	57,500	0.003	75,000	.....
40,000	0.00125	60,000	0.0035	77,500	.....
42,500	0.00125	62,500	0.004	80,000	.....
45,000	0.00125	65,000	0.005*	83,700	Failure
47,500	0.00125	.....	.....	.....	.....

* Elastic limit.

† Permanent set, 0.002 inch

As a matter of fact, of course, more than one tooth of the pinion carries the load when engaged with the rack and so the factor of safety is still higher. The table was compiled from the record of the test made by James H. Herron, mechanical engineer for the Lucas Machine Tool Co.

* * *

F. E. R.

ELECTRICAL PRECIPITATION OF SUSPENDED MATTER

The dispersal of fog by electrical precipitation is theoretically possible, and perhaps it may be developed to a practical state that will render navigation safe in harbors and other dangerous places when fogs are thick. It was known as early as 1824 that finely divided particles carried in suspension in the air could be deposited on a plate by means of

the brush discharge from a static machine. No practical progress was made, however, owing to the fact that the static machines then available were entirely inadequate for any commercial application. In 1850 the same phenomenon was reported in the *Mechanics Magazine* of London, and attention was called to the fact that it provided a means of throwing down finely divided particles carried in suspension in the air. In 1884, Sir Oliver Lodge, without knowledge of previous discoveries, reported before a meeting of the British Society of the Chemical Industry his discovery of this phenomenon, and patents upon the general principle were taken out at that time in Great Britain and several other countries. In 1905 Prof. Cottrell, then connected with the University of California, took up the work. He instituted the 'high-potential direct current for the static machine formerly employed, and arranged to tap off the peak of the voltage wave from a high-potential alternating-current circuit, thus securing a high-potential unidirectional source of energy. This permitted the practical application of the process to sulphuric acid plants, powder works, cement plants and smelters. At Riverside, Cal., ninety tons of cement dust per day are recovered from the flues of the Riverside Portland Cement Works by this process, with a power expenditure of only 35 kilowatts.

The theory of the process is that the solid conducting particles in suspension become charged in passing through the intense static field formed by a voltage of from 30,000 to 60,000 volts. These particles are driven away from the field of greatest intensity by the interaction between the charge and the static field. Other solid particles are also driven out, doubtless by collision with the charged particles. A recent application of the principle is the removal of tar from producer gas which is to be used in a gas engine. A recent installation for this purpose has been made at the plant of the Ford Motor Co., Detroit, Mich. In passing the gas through an intense static field, the particles of tar become ionized and intense molecular activity results. The fine particles of tar vapor collide and form into large globules, which are then easily removed by mechanical filtration. Electrical precipitation has been experimented with as a means of solving the smoke problem, but it has not been so successful along these lines as it has been in the commercial applications which involve the removal of fumes and dust.

* * *

A SUGGESTION FOR TECHNICAL SCHOOLS

BY HENRY R. GILSON*

The object of all manufacturers is to standardize their different products so that they can be made cheaply in quantity. One concern may be making sewing machines; it may sell tens of thousands a year, yet each part in one of those machines must be interchangeable with the same part in all the other machines. To accomplish this requires an elaborate and complicated set of special tools and gages, on the accuracy and economical operation of which the existence of the concern depends. Another firm may be manufacturing electrical devices, making them in million lots out of sheet metal, requiring dies and presses. These presses may be single-acting, double-acting, automatic or multiple slide as the case requires. This necessitates the design of blanking, forming and drawing dies, also the design of combination dies which perform two or more functions at each operation of the press. Hence, the most important factor in manufacturing today is the correct design and operation of the special tools, dies and gages used, and it is one to which the majority of technical schools throughout the country are paying too little attention, with the result that manufacturers have to train their men along these lines as best they can, or hire them away from someone else.

There is no other form of design which teaches the sense of proportion better, or gives the student greater insight into the strength and use of the different metals, together with hardening, tempering, etc. It further has the advantage of bringing clearly before the student's mind the adaptability, adjustment and range of work of the different ma-

* Consulting Engineer, Ambridge, Pa.

chine tools or presses in connection with which the special tools or dies he is designing are to be used. In other words, it reinforces and broadens his knowledge of the uses of machine tools, and shows him their possibilities. Many special tools are of complicated design, requiring careful calculations.

A clear knowledge of how each part of a machine or device is to be manufactured is vitally important and necessary to the engineer designing and developing it, and that knowledge can only be obtained by actual training in the design and use of special tools. A technical graduate starting in a manufacturing plant is handicapped unless he has some knowledge of this subject. Therefore it would seem that courses of lectures with data sheets, supplemented by work in the drawing-room and shop along these lines would prove a valuable adjunct to the student's training and tend to reduce the gap now existing between the class-room and the plant. It is suggested that parts of a machine or commercial device be taken into the drawing-room, and each student assigned a part which requires a set of machine operations to be performed upon it. Have him lay out the special tools, inspection gages, etc., for manufacturing his parts in quantity, interchangeably, emphasizing the principles governing the proper design, handling and commercial operations of the tools. The men will look with increased interest upon their machine laboratory work, and note many details in connection with machine tools which would otherwise escape their attention.

Is it not true that part of the time which is now devoted in technical schools to general machine, mill or factory design could be spent more profitably as indicated above? No manufacturer takes a graduate directly from the class-room into his engineering department and expects him to lay out a manufacturing plant with its equipment. Work of this nature is undertaken only by engineers of experience who are familiar with all requirements, for capitalists, who have money invested, insist on accurate results in a minimum time, and spend their money only on the best talent obtainable; but an engineer to accomplish these things must be familiar with manufacturing processes, and the most important and universal process is the making of interchangeable parts.

During the last ten years the writer has employed a number of technical graduates who had been out of school less than a year. They had no conception of the design or uses of special tools. Men of this description can figure stresses, strains, etc., which is good, but of the all-important factor of manufacturing they know practically nothing. Manufacturing methods have been revolutionized in the past twenty years, and what the industries need are technical men who can step from the class-room to the plant, and assume their share in producing dividends, without having to pass through a shop training or apprenticeship period of one or more years before their real worth begins to be manifested.

Courses in mathematics and applied mechanics are excellent, but in the senior year should not instruction be given (part of the time at least) more in line with what manufacturers will actually require of a man at the beginning, than to try to instill into the student's mind those things which his employer knows he can obtain successfully only from an engineer of experience and which will come naturally to the student with experience and be in line with the development and broadening of his mind?

* * *

GRINDING MILLING MACHINE TABLES

The Rockford Milling Machine Co., Rockford, Ill., has found that grinding the tops of its milling machine tables on a "Diamond" surface grinder materially improves the character of the surface. The top surface of the table is ground after the slides have been scraped in, the grinding being the last operation. The advantages of this practice are that a very smooth, hard surface is produced that resists wear and that can be easily cleaned. The table top is made an accurate plane by the grinding method and it calipers within limits of 0.00025 inch at the corners, plus or minus, but the

advantage resulting from the hard, smooth surface as regards cleanliness is of more importance. An ordinary planed surface, no matter how smooth it appears to be, can never be wiped perfectly clean with waste or wiping cloths. Small particles of lint will adhere to the minute projections in the surface and chips too small to be readily noticed with the naked eye will remain. These beneath a parallel or a vise throw them out of level and tend to produce inaccurate work. On the ground table the smallest chip is readily seen and removed, and fibers of waste do not adhere.

* * *

PERSONALS

James Rushworth has succeeded Arthur Pletz as secretary and general manager of the Aurora Tool Works, Aurora, Ind.

B. F. Stowell, for the past nine years master mechanic of the Hendee Motorcycle Co., is now with the Van Norman Machine Tool Co., Springfield, Mass., as mechanical engineer.

Lee H. Parker, for the past ten years with the Stone & Webster Engineering Corp., and prior to that with the General Electric Co., has been made president of the Spray Engineering Co., Boston, Mass.

Edward W. Dodge, for many years connected with the Norton Co., Worcester, Mass.—for the past six years in the capacity of sales manager—has resigned; after taking a short rest he will become sales manager of the Waltham Emery Wheel Co., Waltham, Mass.

Paul O. Unger, known as an organizer and systematizer of factories manufacturing registers, typewriters, firearms, etc., has resigned his position as production engineer of the Angdile Computing Scale Co., Elkhart, Ind. Mr. Unger has not yet announced his plans for the future.

Fred A. Geier, president of the Cincinnati Milling Machine Co., Cincinnati, Ohio, has purchased the interest of Larz Anderson in the Cincinnati Shaper Co. and the Cincinnati Gear Cutting Machine Co. of Cincinnati. P. G. March will continue as president. The business will be extended on much broader lines than heretofore.

E. R. Markham, a well-known expert in the heat-treatment of steel, writer of articles on steel and its treatment, and for several years past in charge of the machine shop of the evening school of the Rindge Manual Training School, Boston, Mass., has associated himself with the A. C. Fay Co., Inc., 5 Hanover St., Boston, Mass., as consulting engineer for the purpose of putting casehardening materials on the market.

L. F. Hamilton, in charge of the advertising and specialty department of the National Tube Co., Frick Bldg., Pittsburgh, Pa., has returned from an extended business trip to the Pacific Coast in connection with the exhibit at the Panama-Pacific Exposition. The National Tube Co.'s exhibit is part of the U. S. Steel Corporation's exhibit which is located in the Mines and Metallurgy building and occupies 44,000 square feet—the largest single exhibit at the exposition.

Merrill G. Baker was appointed assistant general manager of sales of the American Vanadium Co., Pittsburg, Pa., taking effect March 1. Mr. Baker was born in 1880 and graduated from Dickinson College in 1904. Immediately upon leaving college he entered the employ of the Cambria Steel Co. in the operating department and was rapidly promoted until he entered the sales department in 1906. In 1912 he became assistant to the general manager of sales in charge of the rail and structural departments, which position he resigned to assume his present duties.

Paul B. Liebermann, formerly assistant chief engineer of the Sprague Electric Works, has joined the Hyatt Roller Bearing Co., Newark, N. J., as engineer of tests. Mr. Liebermann graduated from the Royal Technical Institute, Charlottenburg, Berlin, in 1897, receiving honorable mention for laboratory research work. He followed the German custom of serving an apprenticeship, and then entered the employ of the German-General Electric Co., railway engineering department, of Berlin. In 1902 he became identified with the Sprague Electric Works, having charge of the development of an electric dynamometer. Mr. Liebermann will have full charge of all tests, both laboratory and field, of the Hyatt Roller Bearing Co. for the purpose of determining the exact saying to be effected by the adoption of roller bearings of all applications.

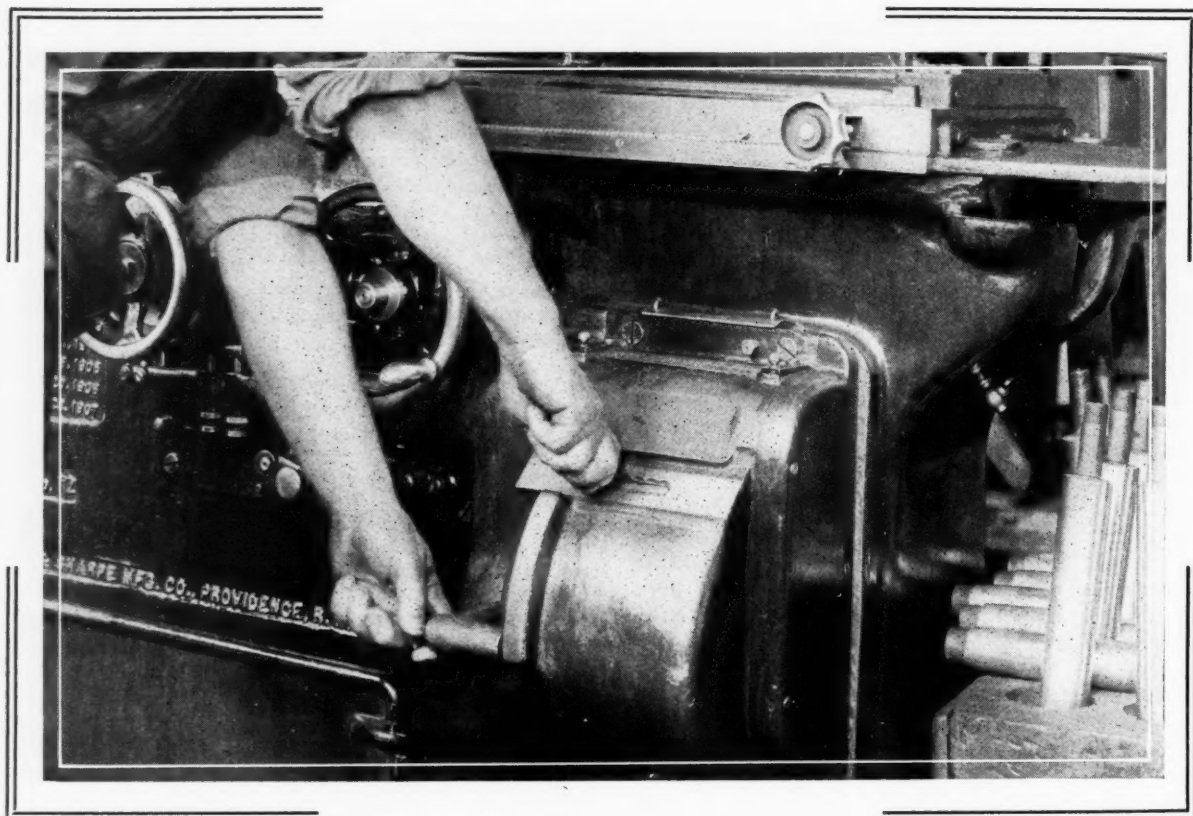
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OBITUARIES

Fred L. Smith of the S. A. Smith Mfg. Co., Brattleboro, Vt., died March 25, aged forty-nine years.

George W. Prentiss, a well-known wire manufacturer of Holyoke, Mass., died April 2, aged eighty-five years.

Phelias Colby, treasurer and manager of the Colby Mfg. Co., Springfield, Mass., died April 11 of pneumonia, aged sixty-two years.



The Picture Tells The Story

At a Glance You Can See One Reason For Fast Production in Grinding Under Conditions That Are Favorable to The Operator

This man is setting up a job on a Brown & Sharpe Plain Grinding Machine. It happens that this particular job has been done before, so the foreman of the grinding department simply gave the operator a record of the work speed and table travel previously used. You can see how easy it is for him to duplicate this combination. A quick-change gear mechanism is located on the machine bed each side of him. He reaches to the one which controls the table travel, drops a lever, moves the index slide knob to the required position and brings the lever into position again. Turning to the mechanism which controls the headstock rotation he does the same thing. The machine is then set, ready to do the job under conditions which assure profitable results.

But even if the job had not been done before, no difficulty would have been experienced. The foreman would tell the man the finish required and indicate in a general way how to get it. The rest could be left to the operator and in the same quick, efficient manner he could try speeds and feeds until the best combination had been secured.

BROWN & SHARPE MFG. COMPANY,

OFFICES: 20 Vesey St., New York; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419, University Block, Syracuse, N. Y.
REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa.; Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O.; Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., and Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perline Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

More Details About These Mechanisms

Each of these quick-change gear mechanisms is self-contained and independent of the other. They give a powerful, positive drive and offer a wide range of speeds and feeds.

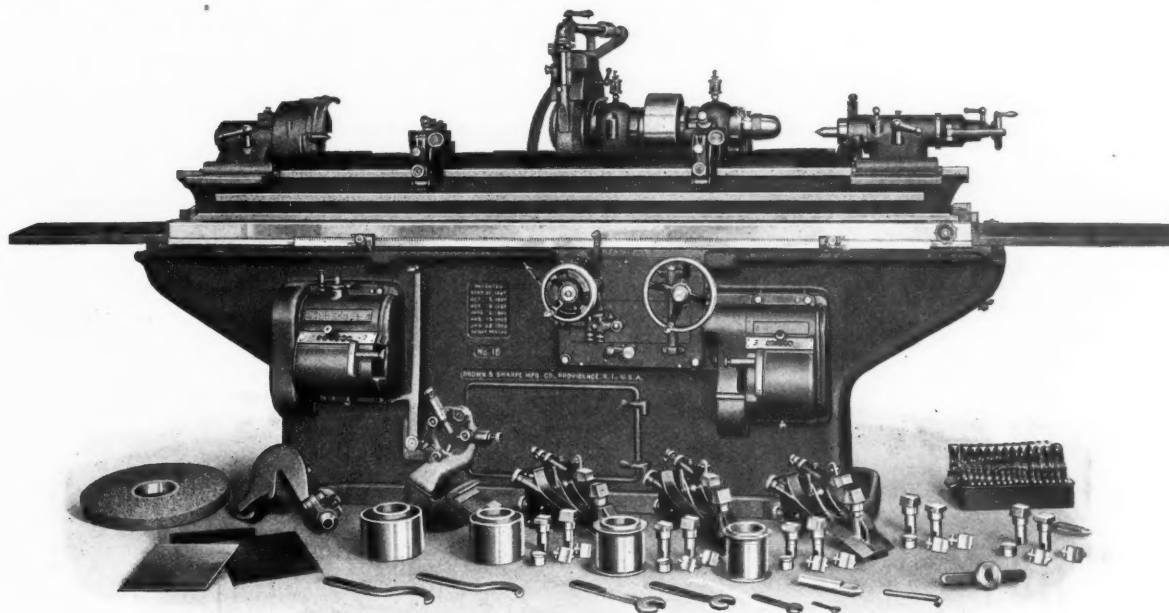
This complete separation of feeds and speeds is an important factor in commercial grinding as it permits the use of any combination of speed and feed for either roughing or finishing, and greatly increases the productivity and usefulness of the machine.

The long lever near the left-hand gear mechanism controls the entire machine independent of the wheel. When thrown in it locks the mechanism, thus preventing damage to the gears through being thrown in while running.

The automatic cross feed, the combination plain and universal back rests, provision for varying wheel speeds, an automatic belt tightener which insures a constant wheel speed, are among interesting features of our line of large manufacturing grinding machines of which the

B. & S. No. 16 Plain Grinding Machine

shown below is typical. It has a capacity for work up to 10" diameter and will take 72" in length. Designed with the features just described, this is a machine that will economically produce accurate, high-grade work and keep your grinding costs uniform and consistently low. Furthermore it is a machine that will find much favor with your operators. Write us for full particulars.



Our Booklet on Grinding Wheels—Free

This booklet will prove invaluable to a grinding machine operator. It fully describes the characteristics and qualities of various wheels and their adaptability to various classes of work. A postal brings you one—free.

PROVIDENCE, RHODE ISLAND, U. S. A.

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THE REX MICROMETER ON PAGE 69

Nathaniel L. Bradley, president of the Bradley & Hubbard Mfg. Co., Meriden, Conn., manufacturer of gas and electrical fixtures, died at his home in Meriden, March 18, aged eighty-four years.

C. W. MacCord, professor emeritus in Stevens Institute of

Technology, Hoboken, N. J., died at his home in Hoboken April 13, aged seventy-nine years. He was connected with Stevens Institute from the time of its opening in 1871. He was the author of a number of books on drawing and machine design.

COMING EVENTS

May 20-21.—Spring convention of the National Machine Tool Builders' Association at Atlantic City. Marlborough-Blenheim Hotel, headquarters. Charles E. Hildreth, general manager, Worcester, Mass.

May 26-28.—Annual convention of the Master Boiler Makers' Association, Chicago, Ill. Harry D. Vought, 95 Liberty St., New York City, secretary.

June 3-5.—Joint convention of the American Supply & Machinery Manufacturers' Association and the National Supply & Machinery Dealers' Association. Hotel Bellevue-Stratford, headquarters, Philadelphia, Pa.

June 7-11.—Third annual convention of the National Association of Corporation Schools at Worcester, Mass. H. W. Dunbar, general chairman of the convention committee, Norton Co., Worcester, Mass.

June 9-11.—Annual convention of the American Railway Master Mechanics Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-17.—Summer meeting of the Society of Automobile Engineers on board the steamer "Noronic" of the Northern Navigation Co., leaving Detroit June 14. Coker F. Clarkson, secretary, 1746 Broadway, New York City.

June 19-26.—Annual convention of National Graphic Arts Exposition in the Coliseum, Chicago, Ill. Publicity manager, A. D. V. Storey, National Exposition Co., 200 Fifth Ave., New York City.

June 22-25.—Spring meeting of the American Society of Mechanical Engineers at Buffalo, N. Y. David Bell, chairman of the general committee, Buffalo; C. W. Rice, secretary, 29 W. 39th St., New York City.

June 22-26.—Annual convention of the American Society for Testing Materials. Hotel Traymore, Atlantic City, N. J., headquarters. Edward Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

July 19-21.—Seventh annual convention of the American Railway Tool Foremen's Association, Chicago, Ill. Hotel Sherman, headquarters. Owen D. Kinsey, secretary and treasurer, 7223 Ridgeland Ave., Chicago, Ill.

August 17.—Annual meeting of the International Railroad Blacksmiths' Association, Philadelphia, Pa. A. L. Woodworth, secretary-treasurer, C. H. & D. Railway, Lima, Ohio.

September 9-11.—Swedish engineering convention in the United States; meeting in Chicago. Secretary, Eastern organization committee, E. Oberg, 183 68th St., Brooklyn, N. Y.; secretary Western organization committee, C. G. Axell, 601 City Hall Square Bldg., Chicago, Ill.

September 25-October 2.—Annual exhibit of the Foundry and Machine Exhibition Co., Atlantic City, N. J., in conjunction with the American Foundrymen's Association convention. Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 27-October 1.—Annual convention of the American Foundrymen's Association, Atlantic City, N. J.

SOCIETIES, SCHOOLS AND COLLEGES

Syracuse University, Syracuse, N. Y. Catalogue for 1915-16 containing roster and courses, including the courses of the fourteenth summer session from July 5 to August 13.

Massachusetts Institute of Technology, Boston, Mass. Bulletin of summer courses for 1915 in architecture, biology and public health, chemistry, civil engineering, drawing, electrical engineering, English, mathematics, mechanical engineering, mechanical arts, mechanics, modern languages and physics.

Columbia University, New York City. Bulletin of the summer session, 1915, comprising day and evening classes in accounting, architecture, assaying, bookkeeping, civil engineering, chemistry, economics, electrical engineering, law, mathematics, mechanical drawing, mechanics, medicine, mineralogy, metallurgy, physics, etc.

Swedish Engineering Convention in the United States, 1915. Secretary of Eastern Organization Committee, Erik Oberg, 183 68th St., Brooklyn, N. Y. Program of the Swedish Engineering convention to be held in Chicago, September 9-11, 1915, containing advance list of members who have announced their intention to participate. Up to the present this list includes 170 names from the United States and it is expected that this number will be doubled. About 50 engineers from Sweden are expected to attend.

National Association of Master Steam and Hot Water Fitters, 260 W. Broadway, New York City. Chart of the 1915 U. S. Standard Schedule of Flanged Fittings and Flanges, adopted March 20, 1914, by a joint committee of the National Association of Master Steam and Hot Water Fitters, the

American Society of Mechanical Engineers and the Committee of the Manufacturers on Standardization of Fittings and Valves, and applying to standard weight fittings for 125 pounds working pressure and extra heavy fittings for 250 pounds working pressure. Price of chart, \$1.

University of Wisconsin, Madison, Wis. Bulletin of the fifteenth annual summer session of the college of engineering, which will be held at Madison during the six weeks period beginning June 21. Special courses will be given in electrical, steam, and hydraulic engineering, gas engines, machine design, mechanical drawing, mechanics, shopwork and surveying. All courses in the university summer session are open to engineering students. Special courses have been arranged for manual arts and vocational teachers. Further information can be obtained by addressing Dean F. E. Turneaure, Madison, Wis.

Pratt Institute, Brooklyn, N. Y., held the annual exhibition of day work April 29-May 1, inclusive, during which time the exhibition was open to the public and the students were engaged in their regular work, thus affording visitors an opportunity to inspect the methods, equipment and general facilities of the school for conducting practical training. Pratt Institute is a pioneer in the field of industrial education and for many years has been developing courses of the kind for which there is so great a demand today. The school offers day and evening courses for both men and women in a great variety of vocational subjects, including fine and applied arts, household science and arts, architectural design and construction, library management, kindergarten training and technical and trade courses for men along many important lines. The school of science and technology especially is of interest to men engaged in technical and trade pursuits. It provides instruction in applied mechanics and machine design, applied electricity, applied chemistry and tanning, machine work and toolmaking, carpentry and building, pattern-making, plumbing, foundry and forge work and sheet metal work.

NEW BOOKS AND PAMPHLETS

How to Make a Low-Pressure Transformer. By F. E. Austin. 14 pages, 4½ by 7 inches. Illustrated. Published by Prof. F. E. Austin, Hanover, N. H. Price, 25 cents.

This pamphlet describes the construction of a transformer to reduce electrical pressure from 110 volts to about 8 volts as a minimum, for experimental purposes, such as operating low voltage tungsten lamps, ringing door bells, etc. The directions should enable an amateur to make a successful transformer having good efficiency. The author states that the efficiency of transformers made in accordance with his instructions has been found to be over 90 per cent in many cases, and never below 85 per cent.

Directions for Designing, Making and Operating High-pressure Transformers. By F. E. Austin. 46 pages, 4½ by 7½ inches. 21 illustrations. Published by Prof. F. E. Austin, Hanover, N. H. Price, 50 cents.

This pamphlet is a companion to the author's work on making a transformer for low pressures. It describes the making of a step-up transformer, giving 20,000 volts, for wireless telegraphs, telephones, for operating tube lamps and X-ray tubes. The mathematical matter is treated in a simple way that is well within the comprehension of the amateur who would be interested in building a high-pressure transformer for experimental purposes. All materials are specified and all calculations are worked out for the model described. Probably no exercise would give the average student a firmer grasp of electrical principles than the building of a piece of apparatus like this transformer.

Gurney Ball Bearing Handbook. 140 pages, 5½ by 8½ inches. Published by the Gurney Ball Bearing Co., Jamestown, N. Y. Price, loose leaf, unbound, \$1.50; bound in plain covers, \$1.75; in flexible loose leaf binders, \$2.50.

The data were compiled chiefly in the interest of the automobile trade and comprise the following: Ball bearing data, general static tables, front hub bearings, transmission bearings of gasoline pleasure cars, transmission bearings of gasoline commercial cars, third member bearings of gasoline pleasure cars, third member bearings of electric pleasure cars, third member bearings of gasoline commercial cars, differential bearings of gasoline pleasure cars, differential bearings of electric pleasure cars, differential bearings of gasoline commercial cars, rear hub bearings of gasoline pleasure cars, rear hub bearings of electric pleasure cars, rear hub bearings of gasoline commercial cars, rear hub bearings of electric commercial cars. These data should be of value to all classes of engineers connected in any way with motor car problems and the general problems of power transmission.

Machine Shop Management. By John H. Van Deventer. 374 pages, 4 by 6½ inches. Illustrated. Published by McGraw-Hill Book Co., Inc., New York City. Price, \$2.50.

This work is gotten up in handbook style; it is printed on thin paper and bound in flexible leather, making it convenient to carry in the pocket or keep on the desk. In selecting the matter for this book for machine shop executives, two tests were applied to the material, viz: "Does it relate to an element

or mechanism of machine shop management actually in use?" and "Can the element or mechanism be used in all probability in other machine shops?" If the answer was negative, the material was rejected. Hence, the result is a book well suited to the busy executive in charge of machine shops or plants including machine shops. The contents follow: Organization; Systems; Committee Plans; Suggestion Systems; Apprenticeship; Functions of Drafting Department; Systems of Numbering Product Parts; Standardization of Drawings; Unit Assemblies; Filing Methods; Changes; Finish, Limits and Checking; Selection of Equipment; Installation and Repair; Machine Numbering; Machine Location and Arrangement; Power Required by Various Tools; Tool-room Methods; Standardization of Machines and Tools; Purchase Methods; Shop and Production Orders; Stock and Stores Methods; Physical Inventory; Inspection; Routing; Dispatching; Scheduling; Steering and Tracing; Time Keeping; Working Hours; Pay-roll Methods; Time Study; Rate Setting; Instruction and Operation Cards; Compensation and Wage Methods; Costs; Burden; Sources of Cost Information; Duties of a Traffic Manager; Causes of Delay in Shipments; Tracing Methods; Safety; Mechanical Safeguards; Fire Prevention; Sanitation.

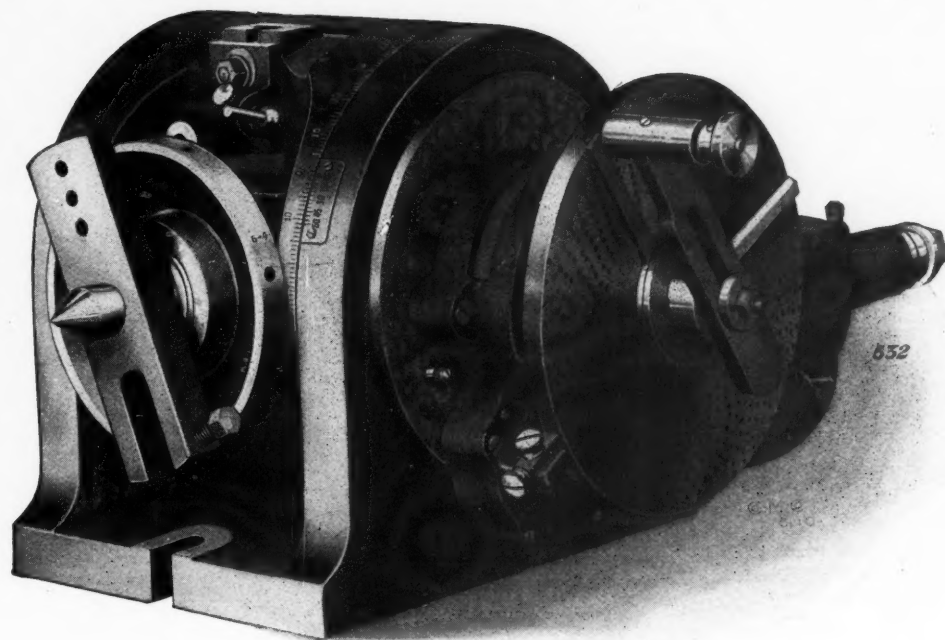
Factors in Foreign Trade. 56 pages, 6 by 9 inches. Published by the Bureau of Manufactures, Department of Commerce and Labor, Washington, D. C., as No. 7 of the Miscellaneous Series.

This valuable government publication deals with the factors in foreign trade of greatest importance to American manufacturers, viz., language, currency, weights and measures, postal rates and parcel post facilities. Data on language, currency, weights and measures and postage are included for the following countries: Canada, Mexico, Newfoundland, St. Pierre and Miquelon, British Honduras, Costa Rica, Nicaragua, Guatemala, Honduras, Panama, Salvador, British West Indies, Cuba, Danish West Indies, Dominican Republic, Dutch West Indies, French West Indies, Haiti, Porto Rico, Argentina, Bolivia, Brazil, British Guiana, Chili, Colombia, Dutch Guiana, Ecuador, French Guiana, Paraguay, Peru, Uruguay, Venezuela, Austria-Hungary, Belgium, Bulgaria, Denmark, Finland, France, Germany, Greece, Italy, Malta, Netherlands, Norway, Portugal, Roumania, Russia, Serbia, Spain, Sweden, Switzerland, Turkey, United Kingdom, British India, Ceylon, China, Dutch East Indies, French Indo-China, Japan, Persia, Siam, Straits Settlements, Australia and New Zealand, Philippines, Society Islands, Abyssinia, Algeria, Belgian Congo, British East Africa, British South Africa, British West Africa, Egypt, French Africa, German Africa, Italian Africa, Liberia, Madagascar, Mauritius and Seychelles, Morocco, Portuguese East Africa, Portuguese West Africa, Tripoli, Barbary, Tunis, Zanzibar. Equivalents of metric weights and measures, conversion tables, price comparison and foreign currency and signs and abbreviations—data of use to all concerns dealing with foreign countries—are included.

The A B C of Iron and Steel. Edited by A. O. Backert. 354 pages, 8 by 11 inches. 222 illustrations. Published by the Penton Publishing Co., Cleveland, Ohio. Price, \$5.

The Penton Publishing Co., publisher of the "Iron Trade Review," has, by this book, added a valuable work to the literature of the iron and steel industry. This literature is already extensive, but most of it presupposes a considerable knowledge of all the branches of the business. The present book, however, provides a means whereby the large number of people engaged in mechanical work, who are anxious to become familiar with the methods and processes of one of the country's most important industries, may do so through the medium of a book specifically written for the purpose, and covering the subject in broad, general outline, giving a satisfactory perspective of the whole industry. The work is, therefore, in a sense, elementary in nature, but covers fully not only the practical but the commercial phases of the industry to which it is devoted. The volume furnishes a simple, concise and at the same time comprehensive exposition of the primary processes involved in the conversion of iron ore into finished forms, and it should be of great interest to those who are eager to get a general idea of the processes which iron and steel pass through from the mine until they are ready to be delivered into the hands of the user. The processes are described by men who are recognized authorities on the subjects on which they have written. It is, however, impossible in this brief review to mention the names of these writers; it is of more importance to give the heads of the eighteen chapters in order to indicate the field covered by the book. These are as follows: Iron Ore and Mining Operations; Beneficiating Iron Ores; How to Determine Value of Iron Ores; Transportation of Ore on Great Lakes; Ore-handling at Lower Lake Ports; Manufacture of Bee-hive Coke; Manufacture of By-product Coke; Manufacture of Pig Iron; Manufacture of Wrought Iron; Manufacture of Crucible Steel; Manufacture of Bessemer Steel; Manufacture of Open-hearth Steel; The Rolling Mill Industry; Wire and Wire Rods; Manufacture of Gray Iron Castings; Manufacture of Malleable Castings; Manufacture of Steel Castings; Electric Steel. In addition, the book contains statistics of the American iron and steel industry, a directory of the iron and steel works of the United States and Canada, and a directory of manufacturers of iron and steel in the United States and Canada, classified by products. An index, well compiled, completes the book.

CINCINNATI TOOL ROOM MILLERS

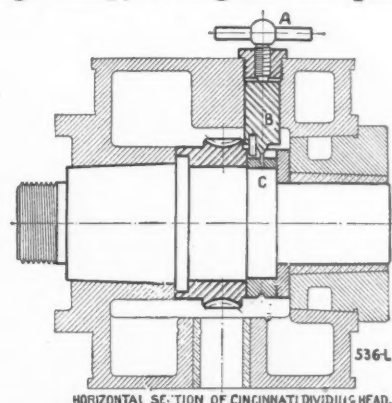


You probably use a UNIVERSAL DIVIDING HEAD more than anything else in the tool room. You frequently want to set the spindle at an angle, and you should be able to clamp the spindle carrier in any position so rigidly that it can't move under a cut.

The DIVIDING HEAD on all Cincinnati Universal Tool Room Millers provides for this. The spindle carrier swings on large trunnions ($8\frac{1}{2}$ " diameter on the 12" head) which are held by clamps gripping their entire circumference. They will not be distorted by continuous use and the carrier will not move under a cut. The alignment of the spindle will therefore be maintained. When taking a cut it is desirable to clamp the spindle. Ours is provided with an aligning clamp, acting on the spindle endwise, holding it securely between shoulders and at the same time adjusting it closer to its bearing. This insures the greatest operating accuracy.

It is provided with the usual universal side index plate and also a direct indexing plate on the spindle for low numbers. The change from one system of indexing to the other is made in a few seconds without disturbing any adjustments. We test the alignments and indexing of every head to closer limits than were thought possible a few years ago. Consider these things when buying a Universal Miller.

Ask for our complete Milling Machine Catalogue.



HORIZONTAL SECTION OF CINCINNATI DIVIDING HEAD.
The spindle clamp consists of a split ring, C, that is spread by the wedge B by tightening the screw A, thus clamping the spindle endwise, securely, without crowding it out of alignment.

The Cincinnati Milling Machine Co.
CINCINNATI, OHIO

NEW CATALOGUES AND CIRCULARS

DeKalb Wagon Co., DeKalb, Ill. Catalogue 5 on DeKalb motor trucks.

George P. Clark Co., Windsor Locks, Conn. Circular of the Clark three-wheel transfer truck made in different capacities from 1000 to 2200 pounds.

Dodge Mfg. Co., Mishawaka, Ind. Circular of the Dodge adjustable wall and socket bracket hangers with standard and self-oiling bearings.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 4032 descriptive of the Ingersoll-Rand "Jack-hammer" equipped with type "JM-6" mounting.

Northern Engineering Works, Detroit, Mich. Bulletin 33, descriptive of air hoists, air jacks, pneumatic traveling cranes and pneumatic jib cranes.

General Electric Co., Schenectady, N. Y. Bulletin 40500, devoted to the subject of alternating-current generators for direct connection to reciprocating engines.

General Electric Co., Schenectady, N. Y. Bulletin 48015 illustrating and describing Type M transformer for operating electric stop motion of textile machinery.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Pamphlet describing "Nonpareil" high-pressure covering for high-pressure and superheated steam lines, boilers and other heated surfaces.

Bridgeport Engineering Co., Bridgeport, Conn. Catalogue of Bridgeport wood-working tools, including patternmakers' sander, trimmer, miter box, metal-top saw table and quick-acting clamps.

Cooper Hewitt Electric Co., Eighth and Grand Sts., Hoboken, N. J. Catalogue of Cooper-Hewitt electric lamps for all photographic processes, supplied in direct-current or alternating-current outfits.

Peerless Electric Co., Warren, Ohio. Bulletin 34 containing data on "Peerless" multipolar motors and generators. Bulletin 36 on "Peerless" direct-current bipolar generators and motors of fractional horsepower sizes.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Pamphlet entitled "Good Furnaces made Better," descriptive of some of the applications of "Nonpareil" insulating brick in heat-treating furnaces, enameling plants, furnace doors, ovens, etc.

Spray Engineering Co., 93 Federal St., Boston, Mass. Bulletins entitled "Washing and Cooling Air for Steam Turbine Generators," and "Sprays for Cooling Condensing Water," devoted to the subject of systems for cooling and cleaning air and water.

Scranton Pump Co., Scranton, Pa. Bulletin 101 of Scranton duplex piston pumps, illustrating the features of design of these pumps and giving dimensions of the various sizes. The pamphlet also gives directions for setting and operating Scranton pumps.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Bulletin 5000 illustrating various types of hydraulic pumps of sufficient strength to meet every high-pressure requirement. The bulletin also shows a few types of hydraulic valves.

Crescent Tool Co., Jamestown, N. Y., is issuing a series of circulars on its combination and universal pliers and adjustable wrenches. The company will supply these to dealers for distribution with the name of the dealer printed on the front covers.

Surface Combustion Co., 148-150 W. 52nd St., New York City. Pamphlets on surface combustion fires and their industrial applications, describing and illustrating tuyeres and refractory beds designed by Dr. Charles E. Lucke for burning gas efficiently without flame.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 3015 describing the Ingersoll-Rand line of portable air compressors and the work for which they are adapted. The various types are gasoline engine driven, oil engine driven, steam driven and electric driven.

Pittsburg Emery Wheel Co., Rochester, Pa. Standard grinding wheel price-lists and rules for calculating the list prices. 16 pages, 6 by 9 inches. The pamphlet also includes rules for calculating the list prices of special shape wheels, and should be useful to all purchasers of grinding wheels.

Van Dorn & Dutton Co., Cleveland, Ohio. Bulletin 250 entitled "A Feature of Lowest Operating or Maintenance Cost" pertaining to gears and pinions for electric railway, mill and mine service. These gears are heat-treated by the "V. D. & D." processes to insure strength and long service.

Automatic Steam Trap & Specialty Co., Detroit, Mich. Catalogue 8 treating of the "Barton" expansion automatic steam trap and containing illustrations that show a number of applications of this trap. The "Barton" steam trap will operate both vacuum and gravity systems at all pressures.

Chicago & Northwestern Ry., Chicago, Ill. Safety bulletin 15 in the form of a chart showing the reduction in deaths and injuries to the Northwestern Railway men since the organization of the "Safety First" committees. The number killed decreased from 97, in 1910, to 49, in 1914, and the number injured from 8404, in 1910, to 5520, in 1914.

Lagonda Mfg. Co., Springfield, Ohio. Booklet T-1 entitled "Lagonda Boiler Room Specialties," describing and illustrating the various types of "Lagonda" boiler tube cleaners with latest improvements, and boiler quick-repair tools. The book also covers automatic cut-off valve and multiple strainers. Copy may be had on request.

Barrett-Cravens Co., 732 Federal St., Chicago, Ill. Circular of the Barrett ball bearing multi-truck,

capacity up to 4000 pounds, for use in shops, mills, factories, warehouses and all places where boxes and material are handled in large quantities. One man can load and unload the truck instantly, thus saving much time and labor in handling materials.

Schuchardt & Schutte, 90 West St., New York City. Circular of the S. & S. divided machine vises for planing, milling, shaping, drilling, slotting and other machining operations where the ordinary machine parallel vises are commonly used. These vises were designed to economize space, and to hold the work firmly without tendency to lift from the table.

United States Electrical Tool Co., Sixth Ave. and Mt. Hope St., Cincinnati, Ohio. Catalogue 12, illustrating and describing "United States" portable electrically driven hand and breast drills, electric radial drills, electrically driven grinders, and grinding and buffing outfits. The book also includes general instructions on the care of electrical tools.

Otis Elevator Co., 11th Ave and 26th St., New York City. Catalogue descriptive of the various types of gravity spiral conveyors for conveying merchandise, etc., made by this company. The latter part of the book describes ten typical systems used in ten different lines of business for lowering goods on the Otis gravity spiral conveyor.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1003 on Type Q brakes, used chiefly on cranes and other types of hoisting apparatus. Bulletin 1039 on E. C. & M. reversing motor planer drive. This equipment was designed for driving a reversing planer directly by an electric motor which is automatically reversed at the end of the cutting and return strokes.

Woburn Gear Works, Woburn, Mass. Catalogue giving prices, catalogue number, dimensions, etc., for spur gears, racks, internal gears, bevel gears, worm-gears, ratchets, sprockets and chains, etc. This company does not carry many spiral gears in stock, but all kinds and sizes are made promptly to special order, and all kinds of gears are also made to order from rawhide and fiber.

Woods Engineering Co., Alliance, Ohio. Circular of a boring and grinding attachment for milling machines or lathes, especially adapted for re-boring and grinding worn automobile cylinders. The grinding wheel is given a planetary motion, the range of eccentricity being two inches. The attachment is thus applicable to the grinding of multiple cylinders which could not be swung on the centers of their respective bores.

Cincinnati-Bickford Tool Co., Cincinnati, Ohio. Circular of the "Cincinnati" tapping chucks designed to facilitate the operation of tapping in horizontal, upright, and radial drilling machines. The quill of the chuck is provided with ball bearings, so applied as to reduce frictional resistance of the tap leading into the work, and thus to avoid the trouble with stripped threads often encountered with tapping chucks in general.

Fort Wayne Electric Works of General Electric Co., Fort Wayne, Ind., has issued an index of its bulletins, giving the subject, the old series number, and the number of the bulletin that succeeds or is succeeded by each bulletin. Some of the new publications are: Bulletin 45201 on type A transformers of large capacities; Bulletin 46100 on type M demand indicators; and Bulletin 48100 on commutating pole direct-current crane and hoist motor.

Celfor Tool Co., Buchanan, Mich. Catalogue 15, listing and briefly describing all the standard tools comprising the "Celfor" line, which includes twist drills, flat twist drills, flat drills, bonding drills, track bits, centering drills, ratchet drills, oil-tube drills, blacksmith drills, three-fluted drills, four-fluted drills, flue-sheet drills, chucking reamers, taper reamers, locomotive reamers, drill chucks, drill sockets, lathe tool-holders, tool bits, vice cutters, and drill gages.

General Electric Co., Schenectady, N. Y. Bulletin 41500, describing General Electric small direct- and alternating-current motors of the drawn shell type. These are all fractional horsepower motors which have been especially designed for application to the diversified forms of small machines which may be driven by electric power. They range in capacity from 1/30 to 1/4 horsepower, inclusive, are wound for either direct or alternating current, and are furnished for use on circuits of standard voltages.

Automatic Wrench Co., Boston, Mass. Leaflet on the "Barnsley" automatic wrench, which has been designed to meet the demand for a simply constructed quick-acting wrench that can be quickly adjusted to size and used with one hand. The wrench is operated by merely placing the object to be turned between the jaws, and pressing the jaw in, or drawing the jaw in with the thumb-trigger until it strikes the object; the automatic locking clutch then comes into action, holding the work firmly between the jaws.

General Electric Co., Schenectady, N. Y. Bulletin 44404, describing one of the new line of General Electric ventilated commutating pole motors. This motor has a rated capacity of 80 horsepower on 600 volts, but, due to the special feature of induced ventilation, has a greater service capacity than motors of the closed type with the same hourly rating. A more detailed description is given in Bulletin A-4171. The new bulletin contains a schedule of speed tables and characteristic curves of the motor.

Olmsted-Flint Co., Cambridge, Mass., is issuing a pamphlet entitled "The Velap Story," which tells about a new form of lap for leather belting. This lap comprises a dovetail splice, one end of the belt being cut wedge-shaped and inserted into the end of another strip which has been opened up V-shaped to receive it. In applying to pulleys, the apex of the wedge is run in the same direction as the belt travels. Thus no exposed lap ends run against air or pulley, and consequently trouble from lifted lap ends is eliminated.

New Departure Mfg. Co., Bristol, Conn. Catalogue on "New Departure" ball bearings, treating of the ball bearing and its development, what ball bearings mean to the car owner, why the ball bearing has the least friction, the strength of chrome alloy steel balls, the fallacy of the point contact, loads bearings must sustain. The last section of the book contains detailed descriptions of the four types of "New Departure" ball bearings, viz., the double-row bearing, the single-row bearing, the radax ball bearing, and the magneto ball bearing. Tables give dimensions and price lists of these various types.

Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill. Booklet illustrating and describing the No. 19 53-inch Besly grinder. The booklet is illustrated with views taken in a number of plants, showing the grinder under actual working conditions. In this type of grinder the work is laid on the face of the disk wheel and held there by gravity, the grinding wheel being kept loaded with as many pieces as it will accommodate. This machine is used principally for jointing and flattening large work with a comparatively small area of finished surface, such as gear-cases, split shaft bearings, foundry flasks, etc.

George Gorton Machine Co., Racine, Wis. Catalogue on the Gorton 2-E patent heavy-duty cutting-off machine of the 13-inch size. This machine is designed for constant hard service on 3-inch to 13-inch rounds and 3-inch to 9 1/4-inch squares, and it can be used for any other size or shape that will come within a 13-inch circle. The book contains a complete description of the machine, illustrated by half-tones and line drawings that make the various details very clear. The capacity of the machine for heavy work is shown by the full-size reproductions of chips produced by this machine on pages 24 and 25. Some of the cuts actually made by this machine are also illustrated.

Blaisdell Machinery Co., Bradford, Pa. General catalogue on the Blaisdell line of air compressing machinery and vacuum cleaner systems. Some of the subjects treated are: uses of compressed air, compressed air in textile manufacturing, air-lift pumping system, compressed air in steam hammers, extraction of gasoline from natural gas, volumetric efficiency of air compressors, comparison of single and duplex compressors, high compressor speeds, air compressor installation and operation. Following this descriptive matter, a large number of tables are given of value in connection with air compressing machinery. The various types of air compressors made by this firm are also illustrated and described.

Boston Elevated Ry. Co., Boston, Mass. Pamphlet containing data presented to the American Museum of Safety in competition for the Anthony N. Brady Memorial gold medal for the year ending June 30, 1914. The gold medal was awarded to the Boston Elevated Railway Co. by the jury of award, consisting of Blon J. Arnold, Prof. George F. Swain, James McGraw, William J. French, and Frank J. Sprague. The jury awarded the replica of the gold medal in silver to Hon. Russell Adams Sears, general attorney of the company, as the member of the operating staff who has most contributed to the successful record of the company, and the replica in bronze to Henry Vinton Neal, mechanic, an employee of the company whose services were of the greatest value in the promotion of safety and health.

Bantam Anti-Friction Co., Bantam, Conn. Blue-book for 1915, containing data on ball and roller bearings. The appendix comprises a reprint of an article on "Ball Bearings and Roller Bearings" by W. S. Rogers, published in the "Engineering Magazine," that contains information on the design of ball and roller bearings and results obtained in practice with various typical forms. The typography of the book is unusual, the printing being done entirely in blue, and the lettering and illustrations appearing in white. The tables and drawings are all on right-hand pages, the left-hand pages being left open for data or memoranda which the engineer or designer may desire to add from time to time. It has been the aim to make the blue book so complete that the draftsman can design and lay out bearings for any load or speed. Any draftsman or engineer can obtain a copy of this publication upon request.

TRADE NOTES

G. A. Gray Co., Cincinnati, Ohio, builder of Gray planers, has appointed the Swind Machinery Co., Bourse Bldg., Philadelphia, Pa., selling agent in the Philadelphia district.

C & C Electric & Mfg. Co., Garwood, N. J., announces that its St. Louis agent, the Morse Engineering Co., has removed from the Central National Bank Bldg. to the Chemical Bldg.

Hendey Machine Co., Torrington, Conn., has broken ground for a one-story brick addition to its plant, 60 by 90 feet. A large foundry will also be erected in the near future but plans for this have not yet been announced.

Bridgeport Arms Co., Bridgeport, Conn., is a new concern building a large plant in Bridgeport for the manufacture of firearms which, as soon as completed, will give employment to 2000 persons, and to a larger number later.

Burd High Compression Ring Co., Rockford, Ill., has removed its general and executive offices from the Masonic Temple to 307-309 S. Main St., Rockford, where larger quarters have been taken to accommodate its rapidly increasing business.

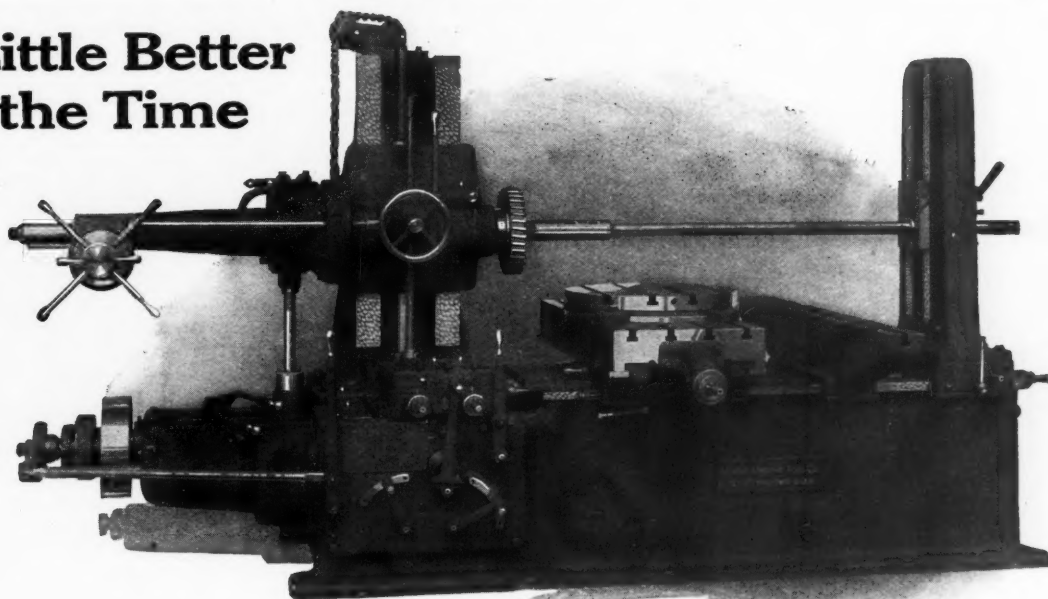
Seth Thomas Co., Thomaston, Conn., will erect a large plant on the site of its present case shop, which will combine the three present plants, movement, case, and marine and watch into one immense plant with a floor space of about 275,000 square feet.

"It is easy to start but it often puzzles the best of us to keep going"

But in spite of this,
we somehow manage to make the

LUCAS "PRECISION" Boring, Drilling and Milling MACHINE

**A Little Better
All the Time**



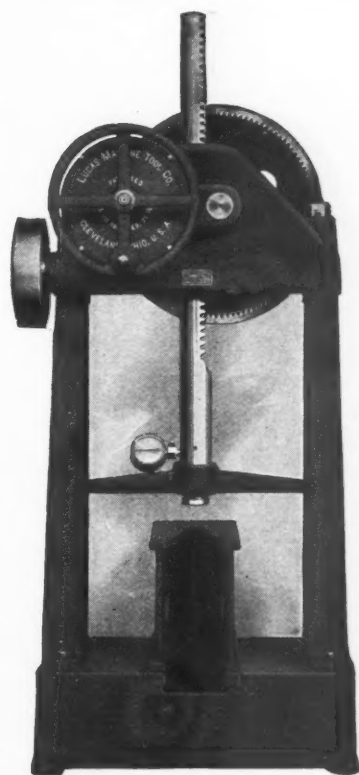
A LUCAS Power Forcing Press and an Honest Man are all you need for Safe Assembling.

The GAGE shows when the work
is together Tight Enough to Stay.

The BELT furnishes the POWER
necessary to accomplish the work.

One Loose Fit may cost more than a
LUCAS Power Forcing Press, so,

**AWAY WITH THE SLEDGE
HAMMER. (You can't put a
Gage on a sledge hammer.)**



LUCAS MACHINE TOOL CO.,



CLEVELAND, O., U.S.A.

Bristol Co., Waterbury, Conn., manufacturer of recording instruments, has removed its Pittsburg branch office from 1870 Frick Annex into better quarters at 832 Frick Bldg., where the Pittsburg district manager, R. B. Anthony, will have his headquarters.

L. Best Co., New York City, agent of the Sterling Grinding Wheel Co., Tiffin, Ohio, manufacturer of grinding wheels and machinery, has moved from 45 Vesey St. to 75 Barclay St., where a larger store has been taken which affords more room for the display of stock.

Cushman Chuck Co., Hartford, Conn., has removed its various departments to its new factory, 106-108 Windsor St., Hartford, Conn. The new building is a one-story structure, amply lighted, and equipped with all modern devices for the comfort and convenience of the employees.

Cleveland Machinery & Supply Co., 58 Wade Bldg., Cleveland, Ohio, is a concern recently incorporated to carry on a general machinery and supply business. S. W. Sparks, formerly general manager of the machinery department of the Cleveland Tool & Supply Co., is the manager.

Delta File Works, Philadelphia, Pa., maker of files, has an exhibit of "Delta" brand files in block 18 in the Building of Varied Industries at the Panama-Pacific Exposition, San Francisco. File users visiting the exposition are requested to inspect the Delta exhibit and make themselves known.

Edward R. Ladew Co., Inc., Glen Cove, Long Island, N. Y., manufacturer of Hoyt's "Flintstone" and "Turtle Waterproof" leather belting, has removed its New York offices to larger quarters at 133-137 Center St., where better facilities provide for prompt deliveries and greater efficiency in its service department.

Pratt & Whitney Co., 111 Broadway, New York City, will vacate its office in the Majestic Bldg., Detroit, Mich., and its store at 52 Larned St. New quarters for both the offices and stores have been obtained in the Kerr Bldg., Beaubien and E. 4th Sts., Detroit, where a complete stock of Pratt &

Whitney small tools will be carried.

Bristol Co., Waterbury, Conn., manufacturer of recording instruments, has an exhibit at the Panama-Pacific Exposition, San Francisco, of Bristol recording instruments for pressure, temperature, electricity, time, speed, motion, humidity, flow, etc. The exhibit includes working demonstration models of some radically new lines.

Mumford Molding Machine Co., Chicago, Ill., has not been taken over by the E. H. Mumford Co., Elizabethport, N. J., as was stated in the April number. The E. H. Mumford Co. has acquired the patents under which the Mumford Molding Machine Co. has been operating since 1900, and will build the machines independently of the Mumford Molding Machine Co.

Warner & Swasey Co., Cleveland, Ohio, has been awarded the contract for the construction of a sixty-inch reflecting telescope for the National Observatory of Argentina at Cordova. The mirror for the telescope is a glass disk sixty-one inches diameter, eight inches thick, weighing one ton. The tube is twenty-seven feet long and six feet in diameter, and with its accessories will weigh more than fourteen tons.

Yale & Towne Mfg. Co., 9 E. 40th St., New York City, has issued a statement regarding the recent election of Henry R. Towne to the position of chairman of the board, and the succession of Walter C. Allen, formerly vice-president and general manager to the position of president. Mr. Towne has been forty-six years with the company; Mr. Allen, twenty-three years; Schuyler Merritt, vice-president, thirty-eight years; J. H. Towne, secretary, twenty-four years; John B. Milliken, treasurer, five years; and Joseph A. Horne, general superintendent of the works, twenty-four years.

Cling-Surface Co., 1018 Niagara St., Buffalo, N. Y., announces that an improvement has been made in "Cling-Surface" to render it more easily applied. Heretofore it has been necessary to heat "Cling-Surface" before applying it to belts, but in the new form it is a semi-fluid, ready for use at any temperature above 60 degrees F. The improve-

ment simplifies application and should extend its use. An eighteen-inch stick with a two-inch strip of cloth secured to the end, dipped in the semi-fluid, serves for applying it to the face of the belt. The pulleys, in turn, distribute and work it into the belt fabric.

A. C. Fay Co., Inc., 5 Hanover St., Boston, Mass., will put on the market five brands of casehardening material as follows: "Salamander" casehardening compound; "Pan American" casehardening compound; "Perfex" mixture, pack-hardening material for tool steel; and charred leather. "Salamander" is a rapid penetrating casehardening mixture for box hardening. It penetrates rapidly, leaves a smooth fine-grained case without a pronounced line of demarcation between case and core; "Pan American" is a mixture having the good qualities of "Salamander" but is not so rapid in action; "Perfex" is a casehardening mixture for high carbon open-hearth and alloy steels where extreme strength and toughness are essential; pack-hardening material for tool steel, as its name implies, is for use in packing tools when pack-hardening; the charred leather will be a high-grade material made from heavy leather properly charred.

H. E. Franklin Mfg. Co., 403 S. Geddes St., Syracuse, N. Y., has begun the construction of an addition 53 feet wide, 100 feet long, three stories and basement, which will be devoted exclusively to the manufacture of die-castings. The die-casting department of the company is now located in the main building on Geddes St., and as soon as the new building is ready, it will be removed to give space for the manufacture of automobiles. The new structure will be of fireproof construction—steel, concrete and brick being used. The first floor will have an office, where all the business of the casting industry will be handled, and a toolmaking shop. The second floor will be used for packing, cleaning and shipping, and the foundry will be on the third floor. A storeroom for raw materials and the vault for dies will be in the basement. The addition will provide for doubling the output of the die-casting department. Employment is now given to about one hundred men on die-castings alone.

Classified Advertisements—Situations, Help Wanted, For Sale, etc.

Advertisements in this column, 20 cents a line, seven words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

HELP WANTED

WANTED AGENTS.—Saunders' Pocket "Hand Book of Practical Mechanics" for tool chest \$1.00 only. Why pay more? It fills bill for shop kinks, ready reference, simple arithmetic. Send for circular. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

SUPERINTENDENT.—For flatbed printing press factory near New York; must be high-grade, experienced executive familiar with modern efficiency methods and possessing keen initiative. Give age, references and salary expected. Box 728, care MACHINERY, 148 Lafayette St., New York.

FIRST-CLASS STEAM AND BOARD HAMMER MEN and die sinkers. Box 732, care MACHINERY, 148 Lafayette St., New York.

CONTRACT WORK

HARDENING, CARBONIZING, GALVANIZING. C. U. SCOTT, Head of Wall St., Davenport, Iowa. **AUTOMATIC AND SPECIAL MACHINES** designed. Working drawings. Tracings. Special Tools and Fixtures designed. C. W. PITMAN, 3519 Frankford Ave., Philadelphia, Pa.

WE ARE EXCEPTIONALLY WELL FITTED to build your light and medium weight machines on contract in reasonable lots. Can store finished material, shipping direct to consumer your single orders or in lots and take the factory end entirely off your hands. Best of shipping facilities. Prompt and efficient service. High-class workmanship. Prices right. HOYSRADT & CASE, Kingston, N. Y.

PATENTS

BUSINESS OPPORTUNITY.—PATENTS SOLD. Patents for sale. PATENT AGENCY, Gouverneur, N. J.

PATENTS SECURED.—C. L. PARKER, Ex-member Examining Corps, U. S. Patent Office. Instructions upon request. 900 G St., N. W., Washington, D. C.

PATENTS.—H. W. T. JENNER, patent attorney and mechanical expert, 606 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

PATENTS.—A book on patents and patent law for the practical man. Contains the principal provisions of the patent law, describes in detail the procedure in obtaining a patent, and deals with patent infringements. Not a book for patent lawyers, but for practical mechanics. Price, 25 cents. MACHINERY, 148 Lafayette St., New York.

SITUATIONS WANTED

TOOL DESIGNER.—Young man, technical graduate, 7 years' experience as machinist and toolmaker. Knows the how and why of jigs and tools. Experienced in gas engines and heavy machinery. Box 730, care MACHINERY, 148 Lafayette St., New York.

MANUFACTURERS' AGENT.—Boston headquarters—covering New England, wants to enlarge operations. An exclusive line is desired, selling to manufacturers and mills. We are established and are getting results. Box 712, care MACHINERY, 148 Lafayette St., New York.

POSITION WANTED, with a good firm, by an experienced machinist and draftsman. Now located in Ohio. Can furnish reliable references. Box 734, care MACHINERY, 148 Lafayette St., New York.

M. E. WITH EXECUTIVE ABILITY; 8 years' experience in shop drafting room and office. Broad experience—power plant supervision, estimating heat treating steel, shop methods, and human nature. American, employed; age 33; married. Box 735, care MACHINERY, 148 Lafayette St., New York.

MANUFACTURERS' AGENT.—Headquarters in Philadelphia—selling to manufacturing plants and railroads in Pennsylvania, New Jersey and Maryland, desires exclusive line. Five years' experience and acquaintance in territory mentioned. Box 733, care MACHINERY, 148 Lafayette St., New York.

EXPERT ACCOUNTANT.—I want to enter your office to devise and install an analytical, labor-saving Accounting System; or to create an accurate system of Cost Finding. Books carefully audited, and financial reports on operations and condition compiled at a moderate charge. Exceptionally broad experience. Strong references from a score of reputable concerns. Address A. A. TAIT, 256 Sterling Place, Brooklyn, N. Y.

FOR SALE

HILL'S TEST INDICATOR on approval. Circular. M. B. HILL MFG. CO., Worcester, Mass.

GET A "LAST-WORD."—The Test Indicator Par Excellence. H. A. LOWE, 1374 E. 88th St., Cleveland, O.

COMBINED THREAD AND CUTTING-OFF TOOL. Sent on approval. Circular. M. B. HILL MFG. CO., Worcester, Mass.

100 HORSE POWER ELYRIA TANDEM GAS ENGINE with air tank and engine. All in good shape. Will sell cheap. THE JACOBS LUMBER COMPANY, Youngstown, Ohio.

ONE NO. 54 MULTIPLE SPINDLE DOUBLE-HEAD AUTOMATIC CHUCKING MACHINE manufactured by the New Britain Machine Company, New Britain, Conn., brand new. Will sacrifice for prompt sale. Not suitable for our present types. For full information address STROMBERG MOTOR DEVICES COMPANY, 64 East 26th Street, Chicago, Illinois.

ATTENTION! MACHINISTS.—\$1.00 buys Saunders' Pocket "Hand Book of Practical Mechanics." Increase your salary. It gets there. Send for circular. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

OVER 100 MACHINES, BARGAIN PRICES. Lathes, Presses, Shears, Forges, Bolt Machinery, Automatics, Shafting, Pulleys, etc. Descriptive list. Prices and photos on request. SHELTON COMPANY, Shelton, Conn.

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21 PIECE WESTERN ELECTRIC CO. INTER-COMMUNICATING TELEPHONE EQUIPMENT. Fine proposition for private factory and office telephone. No "central" needed. A bargain to some concern interested. Write EARLE M. SCOTT, Pur. Agt., Jas. H. Matthews & Co., Inc., Pittsburgh, Pa.

THOMPSON METAL JIG SAW with direct connected 110 V D C gear drive motor 550 to 1100 R. P. M. Will sell either with or without motor at option of purchaser. For further information and price, write EARLE M. SCOTT, Pur. Agt., Jas. H. Matthews & Co., Inc., Pittsburgh, Pa.

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IF YOU ARE REALLY a \$2,500 to \$12,000 man and would consider overtures from desirable firms, signify same by sending your address only (for particulars) to undersigned counsel who will negotiate preliminary correspondence without revealing your name or connection. Strictest professional privacy. R. W. BIXBY, Lock Box 134-J3, Buffalo, N. Y.

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LIVE SHOP AGENTS WANTED to distribute our tools. WELLES CALIPER CO., Milwaukee, Wis.

AGENTS IN EVERY SHOP WANTED to sell my sliding calipers. Liberal commission. ERNST G. SMITH, Tampa, Fla.

WANTED.—USED CORLISS ENGINE 500 to 800 H. P. Send complete data with first letter together with lowest cash price. Box 729, care MACHINERY, 148 Lafayette St., New York.

WANTED FIRST-CLASS, SECOND-HAND 30" LATHE, 24" B. G. Shaper and 4 foot Radial Drill to exchange for San Francisco income property. Box 731, care MACHINERY, 148 Lafayette St., New York.